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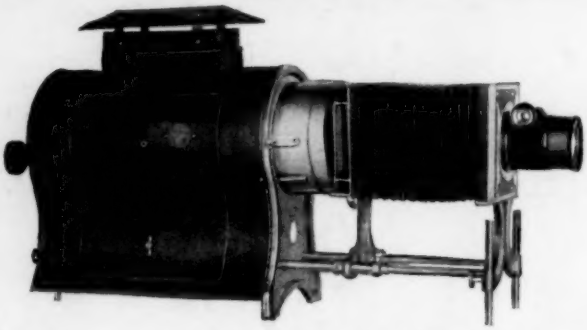

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SCHOOL SCIENCE AND MATHEMATICS

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EDUCATIONAL MOVEMENTS AND GENERAL MATHEMATICS.[1]

BY G. W. MYERS,

The University of Chicago.

It is nothing new to say that many a good movement has gone awry for the sole reason that it was inopportune. To one who is interested in the success of a desirable educational movement, the question whether the movement is timely is important. How may the timeliness of such a movement as that for general mathematics in the high school be gauged?

Without entering upon an adequate discussion of this theme, it may be said with safety that a large factor in determining the timeliness of a reorganization of mathematics along fusion lines is the extent to which it harmonizes with the dominant educational tendencies of the time. This is the phase of the question to be briefly discussed with respect to the movement for general mathematics.

Our first question then is: What are some of the dominant educational movements of the day, that are pertinent to our theme? Doubtless different persons would answer this question differently, and many of you might answer it considerably more correctly than I shall. But I feel it incumbent on me to try some sort of an answer.

As I study current educational literature and listen to educational discussions, I am led to think that one of the leading movements among practical educators is the effort to eliminate the general choppiness of high school programs. One such educator tells me that his main task is now and has been for several years past to do something to reduce the lack of contiguity of the high school subjects. That this lack of contiguity is a strikingly notable feature of our high school programs can be

[1]From an address before the Mathematics Section of the Central Association of Science and Mathematics Teachers at Chicago, November 26, 1915.

readily seen by placing together a typical American program and a typical program of a German gymnasium. I choose a so-called English course such as prevails with minor variations very extensively throughout the North Central States. It is as follows:

First Semester.	*Second Semester.*
FIRST YEAR.	
Algebra	Algebra
English	English
Physical Geography	Physical Geography
Civics	Physiology
SECOND YEAR.	
Ancient history	Ancient history
English	English
Botany	Botany
Arithmetic	Arithmetic
THIRD YEAR.	
Geometry	Geometry
English	English
Medieval history	Medieval history
Political economy	Advanced civics
FOURTH YEAR.	
Physics	Physics
English	English
U. S. history	U. S. history
Solid geometry	Advanced algebra

Perhaps the most striking feature of this course is its lack of dovetailedness. It ought to suit, and probably does suit perfectly, the lover of isolation in the high school. Nothing but the English seems to have any reference to or connection with anything else, and a more careful internal examination of the English courses from year to year reveals little or no attempt of any antecedent course to prepare for, or in any organic way to connect with, a subsequent course. Algebra does not prepare for or relate itself to the arithmetic, nor does either take any cognizance that geometry is to follow. Physical geography does not relate itself to botany, nor does either to anything to come later. The only connection of the history courses is chronological. The course is a veritable hodgepodge of unrelated units, none of which can be claimed to relate itself vitally to the psychological state of the learner in the year in which it is placed. Now contrast with this the typical German secondary program on the next page.

The most obvious feature of this program is the continuity of the work from year to year. Though it does not concern the point under discussion here, it is almost as obvious that the prevailing course is a fractional course.

The justification of a movement to increase the all-around connectedness of the high school subjects of our curricula is clear enough. The attempt to organize a body of general mathematics,

TYPICAL PROGRAM OF A GERMAN GYMNASIUM.

	VI.	V.	IV.	IIIB.	IIIA.	IIB.	IIA.	IB.	IA.	Total.
Religion	3	2	2	2	2	2	2	2	2	19
German and hist. topics	4	3	3	2	2	3	3	3	3	26
Greek	..	..	..	6	6	6	6	6	6	36
Latin	8	8	8	8	8	7	7	7	7	68
French	..	..	4	2	2	3	3	3	3	20
History	..	..	2	2	2	2	3	3	3	17
Geography	2	2	2	1	1	1	..	..	..	9
Mathematics	4	4	4	3	3	4	4	4	4	34
Natural Science	2	2	2	2	2	2	2	2	2	18
Writing	2	2	..	..	..	..	..	..	..	4
Drawing	..	2	2	2	2	..	..	..	..	8
Totals	25	25	29	30	30	30	30	30	30	259

(From J. E. Russell's *German Higher Schools.*)

properly graduated and progressive from year to year, with close regard to the maturing abilities of the pupil, is also plainly enough in harmony with the larger educational movement. As high school teachers are now being trained for the special subjects, they are capable of dealing skilfully with a range of diverse subjects of the sort called for in general mathematics. Indeed, it would seem that the general movement will succeed, if at all, only through this type of correlation within the domains of the several special subjects, at least as a first step.

A second noteworthy movement in general education is the psychologizing of the high school subjects. During the last year a text, entitled *The Psychology of The High School Subjects,* by Charles Hubbard Judd, has appeared from the press of Ginn and Company, and at least two other men have told me since October 1st that they were at work on manuscripts for texts on the same subject. This almost virgin field is being quite vigorously worked just at present. The writers are raising such questions as what are the mental processes involved in knowing this definition, or concept, or algebraic form? This must result in a much clearer perception of the inherent difficulties of mathematical learning, and a more rational adaptation of the high school studies to the powers and aptitudes of high school pupils. Studies of this sort show clearly the incongruities and artificialities implied by treatment of the several subjects separately and are pointing to the desirability and even the necessity of some sort of reorganization of mathematics into the form of general mathematics, more like the sort given in German curricula. General mathematics is thus being pointed out as a psychological necessity of the time. Certainly there is no question of lack

of harmony here between the general and the specific movements toward reorganization.

These writers are raising also such queries as: What is there in child nature that requires formal algebra and nothing else mathematical for him in the thirteenth year of his life, then in his fourteenth year of life, geometry, or arithmetic, and nothing else of a mathematical nature, and so on? What demand of adolescent psychology makes physical geography the exclusive scientific interest in the thirteenth year of life and of no value to the pupil anywhere else in the curriculum? What in the nature of childhood or youth makes botany as a self-contained subject, treated with no regard to anything to come later, the peculiarly appropriate thing for the fourteen- or fifteen-year-old? These are only a few of the troublesome queries the people who are working on the psychology of the high school studies are formulating, and no one yet has had the boldness to step forth to answer them. Queries such as these make a clear call for a reorganization of high school programs and of the special subjects and point in the mathematical domain to general mathematics developed on a sound psychological basis. Surely there is the very opposite of a quarrel between general mathematics and this significant movement in general education.

A third important movement in general education is epitomized by the advent of the junior high school. Realizing that most improvement that gets into the curriculum comes from the administrative domain downward, and not from individual initiative upward, school men are attempting to effect a better adaptation of learning to learner by more intensive administration of smaller program units. The irritating inappropriateness of the late grade and early high school work which, in spite of all criticism and attempted reorganizations of subject-matter of standard textual literature, still persists, is bearing its fruitage in the form of a rapidly spreading belief in the promise of the "six-three-three" plan of administration. This movement is destined to early wide adoption in our school systems and it must make the evil of the existing type of material that is being commonly employed in the seventh, eighth, and ninth grades, glaringly apparent. As has been already pointed out by students of the movement, general mathematics is the only feasible kind of mathematics for the new administrative plan.

In some places the movement has gone only so far as partially to departmentalize the work of the seventh and eighth grades and

to incorporate the ninth with the two preceding grades as an administrative unit. A superintendent, who has carried the junior high school plan to this stage, recently remarked to the writer that the new plan is not likely to accomplish much until the character of the work is much more thoroughly reconstructed and generalized than is implied by mere departmentalizing. He then added we are in sore need of a thoroughly well-organized course in general science, and that this plan is going to force the adoption of union, or general, mathematics. In other words, the thing fusion mathematics is attempting to accomplish for mathematics is just what the leaders of the junior high school movement are urging shall be done with all the studies of this part of the curriculum. Clearly then, we are in fullest harmony with this particular educational movement. The vital question is, are we working along right lines toward general mathematics? Those of us who find ourselves somewhat implicated in the movement for general mathematics claim to be working only in the light that has been vouchsafed to us, and if our critics that approve our ultimate purpose, but deny the suitability of our particular effort, will only use their superior insight to do a better piece of work, we shall be only too glad to give them the limelight.

A fourth movement is the elimination of the "lockstep" in advancing pupils through the grades. School people are coming to accept Mr. Hanus' view that every child has the inalienable right to go forward as fast as he can and as slowly as he must. As subjects are now administered, suppose a bright pupil finishes the course in first-year algebra before the end of the year. What profitable work in this line shall he go on with to the end of the year? He cannot take up the next subjects for they belong to the next year's course and often to other teachers. While his slower colleagues are completing the rest of the year's work, he may do nothing, or review, which at best is a new view and at worst a rehash, or do work extemporized for him that leads nowhere but is supposed to fill his time which he has earned for himself by meritorious achievement, and which too frequently only kills both his time and his enthusiasm for the subject. General mathematics builds right along gradually and progressively, with no hiatus, from year to year, every step both catering to the stage of his attainment and preparing for the next thing, whether in the general plan for the average pupil it is programized for this year or the next. To a very considerable degree, general

mathematics will be found to facilitate the educational movement to provide for individual differences in ability and rate of progress. This has been found to be a fact in the work of The University High School.

There is much interest today in what is called supervised study, the term connoting very much the same as some of us thought we meant but a short while ago by the laboratory method, or plan. The class works during a part, or all, of the class period on the assigned material and under the supervision of the teacher. It is perhaps truer to the legitimate offices of the teacher in a class-study period to think of him as a *supervisor* than to think of him as a *foreman,* which was always strongly suggested by the terms laboratory, and workshop. As a matter of fact a foreman pretty poorly epitomizes the real teacher in a class-study period. The right sort of work for the high school student of mathematics will furnish him opportunities for working with much help, for working with only necessary help, and, finally, for working with no help at all. When a class is getting up its work under the eye of the teacher, as it does in the work of supervised study, the teacher, if he be expert, may judge accurately the extent to which pupils need and are getting the three kinds of necessary experience. He may also get a good line on individual peculiarities and differences and plan better.

The point to be made here is that general mathematics facilitates the use of supervised study. Whether the pupil be geometrically, or arithmetically or algebraically minded, he may attack the problem in hand with whatever tool he finds himself best able to wield. After having gotten the difficulty under control with any one tool, it is not so difficult to master it with another, if that is desired. In the fashion of a true student, the pupil learns to try first this way and then that, until he finds a successful way. Again, general mathematics furnishes a broader and richer field to draw illustrations, applications, and motivations from than does any one of the subjects alone. So far as an adaptable subject-matter can aid in the work of administering instruction that aims to make of the pupil an independent worker, general mathematics facilitates the work of supervised study. It makes possible many better ways of helping pupils to learn how to study and how to think.

The general movement toward economizing human energy and enthusiasm in school can find nothing but assistance in school mathematics from an organization of the material for teaching

into a form under which each important topic is taken up and taught thoroughly, once and only once, and then kept in function continually thereafter. This is of the very essence of economy. The present plan of teaching ratio and proportion, for example, once in arithmetic, then in first-year algebra, then in plane geometry, and in almost the same way every time, finds its excuse for existence in the spurious principle of repetition, not in the principle of economy. The only true economical plan of organization of mathematics is the once-for-all plan of general mathematics.

All these educational movements against which, as a background, we have been attempting to judge of the timeliness of general mathematics, seem to be in agreement with the general plan, if indeed they are not in full harmony in detail. The lack of a varied literature on general mathematics seems to be the chief stock argument against its adoption. That this is not a valid argument will be readily admitted. If we have succeeded in convincing some that general mathematics is no longer a fad, and that it is merely attempting to aid in doing what the leading educational movements are striving to bring about, may we not hope that general mathematics may get a little freer access to the actual problems of the classroom than has yet been given it?

I have been asked to say something about general mathematics in The University High School. As some of you know, this type of material has been in continuous use in this school for a dozen years. I need not report upon phases of the work that have been fully reported upon heretofore.

A revision of *First-year Mathematics* by Mr. E. R. Breslich, head of mathematics in The University High School, appeared from the University Press last August, and it is now in use as the text for the first-year classes. The revised form is working in these classes with excellent satisfaction to all concerned. Mr. Breslich also tells me that the manuscript of the revision of *Second-year Mathematics* will be ready for the publisher by January 1, 1916. Thus the good work is moving on with us.

Two years ago the requirement in mathematics for graduation from the high school was reduced to one year's work. All mathematical courses beyond the first year's work have since then been optional. As matters now stand with us, about 125 students have to take mathematics. Statistics from the principal's office show that of a total enrollment of 420 students, 350 are taking mathematics. Deducting the 125 from the 420 gives 295 students who do not have to take mathematics, and 225 of these are elect-

ing mathematical courses. Stated a little differently, in our school at present a little better than three out of every four students who do not have to take mathematics for graduation, are nevertheless electing mathematical courses. Can any representative of a school using old-line material in mathematics make a better showing for the popularity among its students of the mathematical courses? I am not claiming there are none, but if there are any, I should be delighted to aid such a school to get a little publicity for so meritorious a performance, just now when we are being told that the mathematical courses would be crying for students if they were not required. Indeed, I make the request still broader by asking whether in any sort of school any of the subjects can show a larger percentage of pure election of its courses?

Replying to a *questionnaire* sent to other schools recently as well as to ours, asking students in the mathematical courses whether they liked their mathematical work *very much, a little,* or *not at all,* out of our 350 mathematical students only fifteen said they did not like it at all. A study of these fifteen cases showed that these fifteen students were generally very weak, or that their work had been so seriously interrupted by sickness or other causes as to put them far behind. They were in no state of mind to know whether they liked appropriate work or not. I have not yet learned the numbers in the other two classes suggested by the *questionnaire.*

The failures in mathematics are being kept in the neighborhood of five per cent, and practically no students at all are falling out before the completion of a year's work.

The teaching in our school we think is excellent and special aid is being given to backward students. It is also true that very explicit attempts are being made by all the teachers to take proper cognizance of individual differences. Accordingly, not all the credit for these pleasing results by any means is to be given to general mathematics. General mathematics is only one, but it is claimed that it is an important one, of several factors operating with us for the amelioration of the standard difficulties of mathematical students.

In conclusion, it has been said frequently, and we have again heard it today, that it is very difficult to get a chance to see any real correlating being done in actual mathematical teaching. We are told that many teachers claim to be doing some correlating, but that when their work is inspected, no correlation is in evi-

dence. Let me say that mathematical correlation is now, and for a dozen years has been, a part of the systematic plan for mathematics in The University High School, and that as I do none of the teaching here myself, I very freely invite any of you who care to see it, to visit us at any time. I am almost ready to assure you that you will see correlation, if you can recognize it on sight, any day, and that if you will let it be known that correlation is what you came to see, you will not have to go away disappointed. Finally, you are hereby invited to visit our work at any time, and you will not be required to express your opinion of it for either private or public use, but you may understand that we willingly grant you the privilege to any use of it you may care to make, either public or private. I thank you.

MATHEMATICAL NOTE.

The United States Bureau of Education at Washington has recently issued Bulletin 1915, No. 39, by Dr. I. L. Kandel, on *The Training of Elementary School-teachers in Mathematics* in the countries represented in The International Commission on the Teaching of Mathematics. This is issued with the co-operation and under the direction of the American members of the International Commission on the Teaching of Mathematics, Professors D. E. Smith, W. F. Osgood and J. W. A. Young.

This Bulletin shows the excellent preparation of teachers of elementary mathematics in several of the leading countries in contrast to the meager academic preparation in certain other countries. It is sure to be of interest and value to all who have to do with elementary education in mathematics in the United States.

A METRICAL TRAGEDY.

In the *Scientific Monthly*, December, 1915, Dr. Jos. V. Collins presents in an able and interesting article the good points in the metric system and the great advantages that would accrue to this country if the metric system were adopted. Among the ten good points mentioned are these: The metric units have uniform self-defining names; every reduction is made almost instantaneously by merely moving the decimal point; there are only five tables in the metric system proper; the subject is so much easier for children that a conservative expert estimate of the saving is two-thirds of a year in the child's school life; every ordinary practical problem can be solved conveniently on an adding machine.

After elaborating some of these points of excellence, Dr. Collins discusses the reasons why the metric system has not been adopted in the United States, and indicates how the change can be made, and how the cost of the change is counterbalanced by greater efficiency and economy in the commercial and manufacturing industries. H. E. C.

MATHEMATICS CLUBS IN SECONDARY SCHOOLS.

By Beulah I. Shoesmith,

Hyde Park High School, Chicago, Ill.

No doubt every teacher of secondary mathematics feels that one of his important problems is that of arousing and holding the interest of his pupils in mathematical work. In the elective work of the third and fourth years, one may expect to find some degree of interest on the part of the pupil, but in freshman algebra or second-year geometry, one frequently encounters the pupil who has "no head for mathematics," who announces cheerfully that he has always found the subject difficult, and seems reconciled to the fact that he is invulnerable to any kind of mathematical instruction. Mathematical recreations and diversions are a legitimate and profitable expenditure of time if, without diluting the instruction, they create such an interest that the hard work which is connected with any course that is worth while does not seem like drudgery, for while valuable discipline may be developed by doing unpleasant tasks, the pupil who attacks his problems in a cheerful and interested frame of mind has a great advantage in accomplishing work and overcoming obstacles.

In addition to the problem of arousing the dull or indifferent pupil from his lethargy, there is the difficulty of keeping the brighter and more original pupils working at concert pitch, so that while we are attempting to create interest we may not kill that which already existed. While more intensive work on the subject in hand may be assigned for extra credit to these more ambitious pupils and other devices may be used to retain their interest, still it is a lamentable fact that the amount of uniformity necessary in classroom work often makes it difficult to bring out the capacity of the individual pupil. Yet we owe it to the excellent pupil to hold his interest, to stimulate his enthusiasm, and by opening up to him new fields of thought, to inspire him to the development of mathematical power of which he may be unconscious. While some of these objects may be accomplished in class, every enthusiastic teacher of mathematics must feel that his opportunities for inspiring the really capable student are much too limited.

The Mathematics Club is at least a partial solution of this difficulty. In such a club it is possible to supplement the work of the classroom by offering opportunities that the class does

not afford, to add to the pupils' fund of mathematical knowledge, to inspire pupils to original work, and to lead them to realize that the subject is rich in interest. Boys and girls who become so interested in the classroom work that they voluntarily remain after school for an hour or more to discuss subjects which have been suggested, and who are constantly reaching out for more information, will be glad of an opportunity to meet regularly for more or less informal discussions, and the work of such a club reacts favorably on the attitude toward mathematics throughout the school.

Probably the first Mathematics Club organized in a secondary school was the one in the Shattuck School at Faribault, Minnesota, organized by Mr. Charles Newhall in 1903. It has been a very successful club with a membership of fifteen boys from the senior class who meet in the evening every two weeks and report upon topics in mathematics assigned to them. Interesting articles have appeared in SCHOOL SCIENCE AND MATHEMATICS, describing the work of this club and indicating the subjects taken up in the course of the year. These include many topics in the history of arithmetic, algebra and geometry, as well as famous problems, puzzles, tricks and diversions. In a recent article on "Recreations in Secondary Mathematics" in the April number of SCHOOL SCIENCE AND MATHEMATICS, Mr. Newhall has given a very comprehensive list of books, magazine articles and general references for such recreations. This article is full of suggestions for teachers who may be interested in organizing clubs in secondary schools, or who may wish to introduce such material for classroom use.

The only clubs with which I am familiar in the Chicago high schools are of recent development. One was organized at Hyde Park High School a little more than two years ago, one at Wendell Phillips soon after, and within the last year one at the Bowen High School. Since these clubs are similar in their organization and general plan, I will describe briefly our experiment at Hyde Park.

Our club came about from a desire on the part of some of the mathematics teachers to appoint a regular time for informal discussions among those groups of interested pupils who often lingered after school to investigate problems which had been suggested to them. It offered an opportunity to bring enthusiastic pupils from different classes together and to direct into profitable channels the interest already created. When the pos-

sibility of organizing a small club was proposed, these pupils were very enthusiastic. From the high school pupils' point of view it was of course imperative that the club be equipped at the outset with constitution and by-laws, a name and a pin. I doubt if any successful club could be organized in high school without these important adjuncts. Officers were elected, a constitution was drawn up, stating that the object of the club should be "to create an interest in and to further the study of mathematics," the organization was called the Pythagorean Club, and it adopted as the official pin the star pentagon, chosen from various mathematical designs submitted by members of the club.

The first members, from twenty-five to thirty in number, were chosen by mathematics teachers and were pupils who had displayed unusual scholarship, interest and originality in regular classroom work. At the beginning of each semester as some members are graduated, they are replaced by new members, but the recommendation by mathematics teachers has continued to be a requirement for election to membership. The club has always been proud of the fact that it is the only one in Hyde Park in which the membership is based upon scholarship and the scholarship requirement has never, to our knowledge, worked an injustice in excluding deserving pupils from membership, since pupils who would be interested in doing the extra work in such a club are almost invariably the ones whose enthusiasm in classroom work would insure their recommendation. On the other hand, it has happened frequently that the possibility of election to membership has spurred a mediocre pupil on to a much higher standard of work, for the club is a popular one and membership in it is regarded as a great honor.

While pupils completing the second semester of plane geometry are eligible to membership, the members are usually elected from classes in advanced algebra, solid geometry, trigonometry or college algebra. Lack of absolute uniformity in preparation has not seriously hampered the Program Committee in the selection of topics, since many subjects are of general interest to third- and fourth-year pupils. Moreover, pupils whose knowledge of trigonometry is limited to the elementary work in this subject done in connection with similar triangles in geometry, are interested in the occasional trigonometric solution of a problem; those whose knowledge of equations does not extend beyond quadratics are glad to hear an occasional cubic or biquadratic discussed by members of college algebra classes, and these discus-

sions often create an interest in the elective courses in mathematics.

Regular program meetings, usually an hour and a half in length, are held every two weeks at the close of school. The President of the club, who is usually a senior who is taking advanced work in mathematics, presides at the meetings while the programs are arranged by a Program Committee appointed by the President at the beginning of each semester. This committee confers with mathematics teachers in regard to the subject matter for each program and also urges club members to propose problems or topics of special interest which they may wish to hear discussed. At each meeting of the club, programs for the next meeting are distributed so that members may be informed two weeks in advance of the topics which will be up for consideration.

While two or three mathematics teachers are usually present at each meeting and contribute something to the general discussion, it is the general policy to leave the meeting in the hands of the members as much as possible and to encourage among them free and informal discussion of any topics in mathematics which may appeal to them. When problems have been proposed for solution and are presented, the teachers place the responsibility upon the club of deciding upon the validity of the proofs presented and of accepting or rejecting the solutions. This custom has tended to make the members more alert, with the result that the solution of an unusually difficult problem frequently provokes animated discussion and argument which continue long past the usual time for adjournment.

The programs have been of great variety. Several meetings have been given over to the discussion of famous problems in geometry. The circle and its triangles have proved to be of great interest, and the nine-point circle always challenges members to an unusual amount of investigation. When one problem of this character furnishes the basis for discussion, the rivalry among the members and the great variety of solutions presented is one of the chief factors of interest.

Early in the organization of the club, a program was announced on the Pythagorean theorem, inasmuch as that theorem had been of special interest in the second semester of geometry and many pupils had indicated a desire to investigate other proofs than those brought up in class. An enormous amount of work was done by the club and the teachers present at the meeting considered the results surprising. In some cases possible figures

were suggested, but there was a lively competition among the members in working out original proofs and in the majority of cases both the figure and the proof were original. From the proofs submitted to the Program Committee, ten or twelve were presented at the club meeting. In connection with these proofs, one pupil gave a short account of the history of the theorem, and another gave a sketch of the life of Pythagoras and the work of the Pythagorean school. So much interest was shown in the proofs presented, that a committee was appointed to investigate the published proofs in the city libraries to determine which of our proofs were really new discoveries; figures which were devised by members but which seemed to defy solution were submitted to the club for further consideration; and so much enthusiasm for this noted theorem was created, that geometry pupils began to inquire eagerly when they could take up the Pythagorean theorem.

Concurrency of lines and collinearity of points has opened up an interesting field to the enthusiastic student in geometry, and teachers have been glad to suggest material in these subjects to supplement the meager work which they can do in the average class. The interest in working out the theorems of Menelaus, Ceva and Carnot reached its climax in the solution of Pascal's Mystic Hexagram.

Two of our most successful meetings have been on the general subject of mathematical fallacies, a subject of unfailing interest to the majority of high school students, for they seem to feel for some mysterious reason that it is a much more wonderful feat to prove a fact that cannot possibly be true than to work out rigid and logical demonstrations of the more plausible theorems of algebra or geometry. A notice of a meeting on fallacies created a great demand for library books and other material on the subject, and aroused the interest of pupils who were not members of the club to such an extent that there were numerous requests for permission to attend the meetings. Some of the fallacies were quickly detected, such as the fact that all triangles are isosceles, that an obtuse angle is equal to a right angle, that a quadrilateral with two opposite sides equal is a trapezoid, that two perpendiculars may be drawn from a point to a line, and that the locus of points in a plane equidistant from a given point is not a circle. Some of the algebraic fallacies presented more difficulty, especially those involving the interpretation of equations. The one which defied their efforts for the greatest

length of time, and in consequence caused the greatest amount of excitement, was the proof that a part of a line is equal to the whole line. The hope of finding the flaw in the proof incited pupils to wrestle with intricate points which would have seemed commonplace and prosaic in other situations. They carefully examined the proofs for similarity of triangles; they questioned the comparison of areas; they investigated the operations in proportion involved; they demanded proofs for the theorems of the square on the sides opposite the acute and obtuse angles of a triangle; they cross-questioned themselves and one another with a zeal that would gladden the hearts of any pedagogue; and when the fallacy was finally detected, the fact was emphasized that when two equal fractions have equal numerators, the denominators are not necessarily equal.

Certain types of construction problems have been very popular in the club, and for nearly a year the famous theorem of Apollonius, to construct a circle which shall be tangent to each of three given circles, has been up for consideration. Several members of the club have solved many of the series of construction problems leading up to the final and difficult construction, and recently two members of the club obtained the final construction by independent and original solutions. One of the boys who was successful in arriving at the final solution declared that he had learned more about mathematics in his attempts to solve the theorem of Apollonius than in any course in mathematics which he had taken, and at the two meetings of the club held for the purpose of hearing the two solutions, members agreed that the solutions obtained represented the best work done in the history of the club.

Occasionally the program has consisted of a paper or a talk followed by a discussion. At the request of the members, one of the teachers gave a talk at one of the meetings on "The Fourth Dimension"; a member of the club who had become interested in the parallel postulate gave a talk on that subject; another member who had done a considerable amount of work in astronomy and who edited an astronomical journal, gave an interesting paper on "The Mathematical Phases of the Discovery of Neptune" which he was afterwards invited to read before the Wendell Phillips Club; a member of one of the beginning classes in geometry who had worked out twelve proofs for the fact that the sum of the interior angles of a triangle is equal to two right angles was asked to present his proofs at one of the club meetings.

A Committee on Proofs asks members who have done especially original work to write out demonstrations in permanent form so that they may be preserved. It is hoped that this collection may in time become an interesting one, and that it may be an incentive to future members of the club.

When a program is unusually serious in its nature, the Program Committee often provides for diversion in the way of mathematical tricks, peculiarities, magic squares, etc. One of the greatest sources of amusement has been the initiation of new members at the beginning of each semester, when one of the mathematics teachers publicly tests the ability of new members to perform the fundamental operations of addition, subtraction, multiplication and division, not, however, in their familiar decimal system, but in duodecimals or a system of fives or eights. The struggles and mistakes of those who are being initiated are thoroughly enjoyed by all of the old members of the club and considerable information in regard to these systems of notation is absorbed.

While it is not the intention of teachers or of members of the club to emphasize the social side of the organization, one social meeting is usually held at the beginning of each semester when new members are taken into the club, for it is felt that in a large school an occasional social meeting results in greater freedom and spontaneity in the regular program meetings. At these social affairs all of the entertainment is of a mathematical character, consisting of mathematical charades, contests and games. Members of the club have displayed great cleverness and ingenuity in devising mathematical contests for these occasions. There have been question contests in which all the answers were mathematical terms, art exhibits in which the guests were to guess what well-known propositions were illustrated by the sketches, and thrilling tales have been composed from mathematical symbols and presented to the guests for translation, but while the parties of the Mathematics Club have been lively affairs, it has not been necessary to sugar coat the regular proceedings of the club by holding social meetings frequently. The sustained interest of the members in the serious work of the club has been quite remarkable and very gratifying. The club has been and is a popular one, the meetings are well attended, and the organization is just as enthusiastic now as when it was new and had all of the charm of novelty.

While we consider that our two years' experience with a Mathematics Club at Hyde Park has been largely an experiment,

there is a general agreement that the experiment has been a successful one, resulting in arousing interest in mathematical literature, developing imagination along mathematical lines, cultivating and encouraging the development of power of initiative and original work, and in creating greater interest in all lines of mathematical work throughout the school.

THE MAGNETIC FIELD SURROUNDING A VOLTAIC CELL.

By R. H. Cornish,

Wadleigh High School, New York.

The following facts are well known and their demonstration by the teacher or in the laboratory is included in every course in electricity. (1) A solid conductor carrying a current of electricity is surrounded by a magnetic field, in which (2) the lines of force are in concentric circles with the conductor at the center. (3) The plane of these circles is at right angles to conductor and (4) if you look along the conductor in the direction in which the current is flowing, the lines of force will seem to take a *clockwise* direction around the conductor.

That a voltaic cell in action is surrounded by a magnetic field in every way similar to the field in the wire is not so well known. Textbook writers have either ignored, or assumed, or been ignorant of the fact. The present writer has not found in any book that he has consulted any reference to it.

That such a field should exist in the cell as well as in the external circuit seems a reasonable supposition.

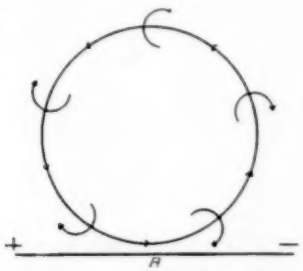


Fig. 1

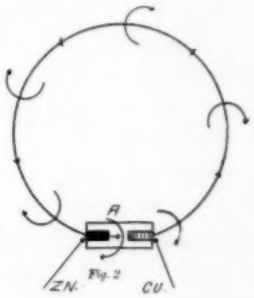


Fig. 2

Suppose as in Figure 1 a wire carrying a current to be bent into a large circle. The direction of the current being indicated by the arrows on the wire, the direction of the lines of force

around the wire, especially at the point A, where the two wires cross, will be indicated by the small circles.

Suppose we substitute for the external source of current in Figure 1 a cell and introduce it at A in Figure 2. Since the direction of the current in the wire is the same, the lines of force must have the same direction around the wire and it would seem natural that the magnetic field should continue and be found to exist in the liquid conductor, that is, in the cell, as it exists in the continuous wire of Figure 1. In order to verify this supposition, the following experiment may be performed.

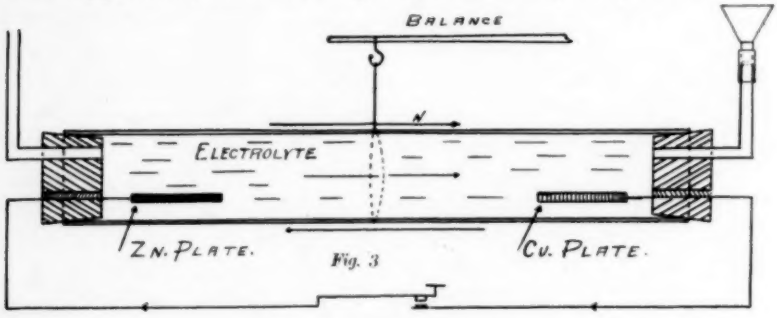


Fig. 3

APPARATUS NEEDED.

Glass tube, 3.5 or 4 cm. diameter and 50 or 60 cm. long. This when completed is the cell.

Two large 2-hole rubber stoppers to fit the ends of the large tube.

Two small glass tubes each having a right angle bend 6 in. and 2 in. long to fit hole in stoppers.

Two short glass rods to close holes in stopper.

One zinc rod amalgamated, with two feet of small No. 22 insulated wire attached.

Battery fluid.

One carbon rod (small) $\frac{1}{2}$ in. diameter or smaller with wire attached.

One small glass funnel.

Supports for the large tube.

Mounted astatic needle to swing, one needle above and one below the middle of the cell. This may be made of the halves of a magnetized very thin knitting needle.

Key or push button.

MANIPULATION.

Mount the large glass tube and other parts which make up the

cell as shown in Figure 3. The wires connected to the zinc and carbon plates should go through the lower holes in the rubber stoppers at each end and then these holes should be plugged with the glass rods. The bent glass tubes should be in the upper holes of stoppers. As much space as possible should separate the end of the zinc rod from the carbon rod.

When all parts are in order the battery fluid may be poured in. The contact may be timed to the period of the astatic needle. By so doing the needle will be found to turn at right angles to the length of the cell. This proves the existence of a magnetic field around the cell and its direction will show that it conforms to the rule stated in (4) above.

This experiment may be extended by substituting copper-sulphate for battery fluid and a copper plate for the zinc plate used. This makes the cell an electroplating cell. If a current is now sent through the cell, the needle turns, showing again that the cell is surrounded by a magnetic field.

No practical value of the fact mentioned is known but its theoretical value is very interesting. This seems to be true. Every portion of a closed conductor, whether liquid or solid, through which a current of electricity is flowing is surrounded by a magnetic field.

AN INGENIOUS METHOD OF TELLING THE DIRECTION OF FLOW OF AN ELECTRIC CURRENT.

By Jessie Caplin,

West High School, Minneapolis, Minn.

Instructors in chemistry and physics always find it difficult to impress upon the minds of their pupils the lesson which will enable them to understand and be able to tell instantly the direction in which a voltaic current is flowing. In electrolytic and ionization discussions in most textbooks, the anode and cathode poles are mentioned, and those who have not had physics, especially, find it very confusing in distinguishing between them.

In order to assist the memory, it is suggested that the word

"PANCAKE"
o n e a
s o g t
i d a h
t e t o
i i d
v v e
e e

be taken and the current supposed to be flowing from the letter "P" to the letter "E." The order of the letters also indicates the direction in which the current is flowing.

AN AUTOMATIC, INTERMITTENT ERUPTION, ARTIFICIAL GEYSER.

By O. D. von Engeln and L. A. Hausman,
Geological Department, Physiography Laboratory, Cornell University.

In the average high school the humble geography classroom, bare often of even a decent globe, can not begin to compete in attractiveness for students with the laboratories for chemistry and physics. In the chemistry laboratory the uninitiated student sees mysterious flasks and retorts, long rows of curiously labeled bottles of reagents; in the physics laboratory extensive equipment of complicated apparatus—all of which excite his interest. School boards, made up of prosaic business men, apparently respond to the same appeal, for it would seem that, presto, at the sound of the magic words, chemistry and physics, the public purse is opened quite freely to supply new complications. On the other hand, too scant attention is accorded requests for such commonplaces as maps and lantern slides for geography teaching. Perhaps this is a reflection of the attitude recorded recently by the business men of St. Louis who solemnly opined that geography had little, if any, direct vocational value. If that is true, one may also ask of what direct vocational value is a knowledge of the time honored H_2SO_4 to the average student. The real difficulty appears to be that geography as taught is entirely too practical to be popular.

Possibly if geography can be made a bit more spectacular, pupils and school boards will be more alive to its merits. Visualizing the subject by means of lantern slides is a step in the right direction and serves especially in teaching the facts of general geography. Many of the topics in the physical geography courses usually given in high schools can also be illustrated with lantern slides to good advantage, especially in view of the tendency at present to put the emphasis on teaching the relation of the environment to the character of the human occupation of a region. But the origin and development of land forms, mountain and valley, plateau and delta, as well as of natural phenomena such as waterfalls, volcanoes, and geysers continue to comprise a large part of the study.

Nor is this unwise from either a practical or cultural point of view. Certainly it is worth while to have a clear understanding of how the region in which one lives or to which one journeys

got its form and features. In any event, such knowledge can be applied a hundred times by the average person before a need arises for an appreciation of H_2SO_4. It is when one travels in the West that one comes to understand, however, how uninformed most people are about natural phenomena. At the Grand Canyon and in the Yellowstone Park one may listen any day to a variety of vague guesses and marvelous explanations of the wonders to be seen in those regions. Accordingly, we can not be remiss in urging that physiography be taught, and taught interestingly enough to attract numbers of students.

So much by way of introduction. The particular purpose of this paper is to give directions for the construction of a model geyser that is both easy to set up and truly simulates the conditions attending the occurrence and eruptions of its natural counterpart. The introduction of this and other like illustrations as classroom experiments will do much to give zest to geographic study. The great difficulty with such attempts usually is that they are not truly representative, that they often fail to fulfil some essential condition of the natural phenomenon. Hence the net result is apt to be a misconception on the part of the students of some phase of the real situation.

This difficulty we think has been overcome in the present instance. In order to make it clear how the apparatus described is conceived to illustrate geyser eruptions, it is first necessary to review the chief facts about geysers. Geysers occur only in Iceland, New Zealand, and the Yellowstone Park. These three regions are at present or have in the recent geological past been the scene of great volcanic activity with attendant flows of lava thousands of feet thick. This lava has cooled at the surface to hard rock, but at no very great depth are hundreds, perhaps thousands, of feet thickness of still very hot rock. This because the very slow conduction of heat by rock permits of only very slow escape of heat from the buried masses, through the cooled outer crust. All known geyser occurrences are along the shores of streams or lakes; in other words, at valley bottoms—places where water seeping into the earth over highland areas normally again comes to the surface in springs. That is, rain and snowfall waters from plateau and mountain areas percolating through the rocks below commonly reappear at the surface in valley bottom areas. In the geyser regions the cool *descending waters penetrate* to the incandescent lavas *through multitudinous minute pores and fissures* and then *ascend through larger openings,* the

geyser and hot spring tubes, to the surface as hot water and steam. Gravity is responsible for the downward motion of the water; gravity (the pressure head of the descending films of water), plus the expansive energy developed by the heating in contact with the hot lava, accounts for the upward motion and reappearance of the water in hot springs and geysers. It is not essential that all the descending water come in contact with the hot lavas. Part of it may be converted into steam of such high temperature as to heat effectively a considerable volume of water that does not penetrate to great depths. The question whether the water will reappear as a geyser with periodic eruptions or as a hot spring with relatively quiet constant ebullition seems to depend on two factors—(*a*) the size of the opening leading to the surface, (*b*) its depth. If the opening is large in comparison to the supply of water and heat energy and if the tube is not of great depth, a hot spring results. On the other hand, a deep tube with high heat at the bottom and a free inflow of water through its sides will favor the geyser phenomenon. As the development of the geyser and hot spring tubes is at least in part due to the solvent action of the hot ascending waters, and to the explosive force of eruptions in the case of geysers, it follows that with increase in the diameter of an opening, a geyser may become a hot spring; by increase in depth of the tube, a hot spring may develop geyser characteristics. As a matter of fact, there are all gradations between the two forms in the Yellowstone Park.

Increase in depth of the tube tends to the development of geyser eruption because the greater the pressure, the higher the temperature necessary to make water boil, i. e., to convert it into steam with much greater volume. Thus while water boils at 212°F. at sea level under atmospheric pressure, it must be heated to a temperature of 293°F. before it can change to steam when weighed down by a column of water 100 feet high. Since the greatest heat is probably most commonly supplied at the bottom of the geyser tubes, it follows that, relatively, very high temperatures must be attained before the water there reaches the boiling point. This may be a very important condition for while the water at the bottom is heating, there is time for the rest of the tube to fill up and develop the requisite pressure. In fact, if the supply of heat is very great in proportion to the supply of water, a constantly erupting steam jet results; e. g., the Black Growler of the Yellowstone. It is also important to note that, coupled with

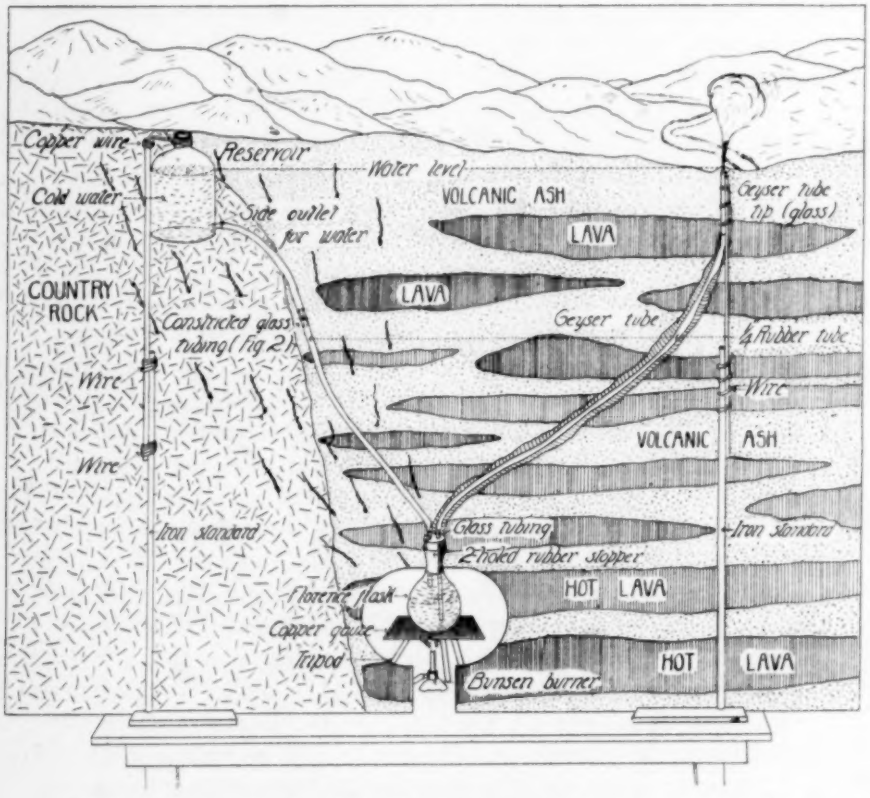
the fact that they open to the surface at higher elevations, the fineness of the rock pores through which the cold water descends prevents their utilization as a path for the rapid geyser expulsions.

A geyser tube accordingly fills up with cold water by percolation through many small fissures. Eventually (the length of time required varying with the volume of water to be heated and the magnitude and temperature of the heat source), the bottom waters in the tube are heated to their high boiling point. A portion of their mass changes to steam with very much greater volume. This lifts all the column of water above. The water at the top of the tube boils over. This relieves the pressure throughout the whole column of water. Hence the water at many points in the lower part of the tube is suddenly enabled to boil, changes to steam, and the expansion of this forces the whole column of water out of the tube and the geyser erupts a mingled mass of water and steam. The eruption begins with a quiet outflow of water, the main outburst is mingled water and steam, the end is a hoarse roar of steam.

The essentials, then, to be provided for a model geyser, faithful in its construction and mechanism to the natural phenomenon, are (*a*) a source of cold water equivalent to the precipitation supplies; (*b*) a method of admitting the cold water supply to the geyser tube with relative slowness, both to simulate the slow percolation through rock pores and fissures and to prevent a back flow of the heated waters; (*c*) a deep-seated source of heat; (*d*) a relatively open geyser tube; (*e*) with a somewhat constructive outlet to differentiate it from a hot spring. These are all supplied in the apparatus figured and described below. The point (*b*) is the particular new thing about this apparatus. Other descriptions of model geysers have appeared recently in the *Scientific American Supplement,* September 23, 1911, and in the *Scientific American,* December 19, 1914; also in the *Encyclopedia Britannica,* 11th Ed., article on "Geysers." The apparatus described is, however, complicated or not directly repesentative of the natural conditions.

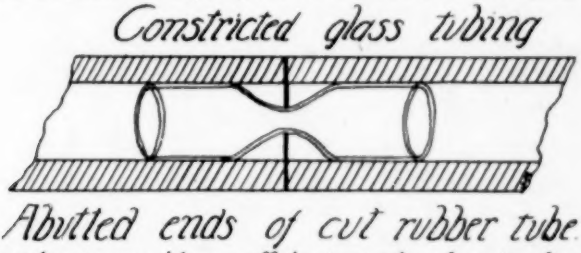
The diagram, Figure 1, is practically self-explanatory. The construction in the tube from the reservoir is made by drawing out a glass tube at one point as shown in Figure 2. The rubber supply tube is cut to permit the insertion of the glass tube construction. Iron stands are used to support the reservoir and the geyser tube. The one supporting the reservoir is made high enough by slipping a section of pipe over the upright stem of the

stand. To this pipe the neck of the bottle is lashed with soft copper wire. Note that the glass tube from the supply reservoir does not penetrate the flask so far as the one leading to the geyser tube. The water level in the flask when boiling begins will be below the supply tube outlet. The two-hole rubber stopper of the flask should be pressed in firmly. The diameter of the nozzle of the geyser tube should be of slightly greater diameter than the diameter of the constriction in the supply tube. The Bunsen burner flame should be quite high and hot.

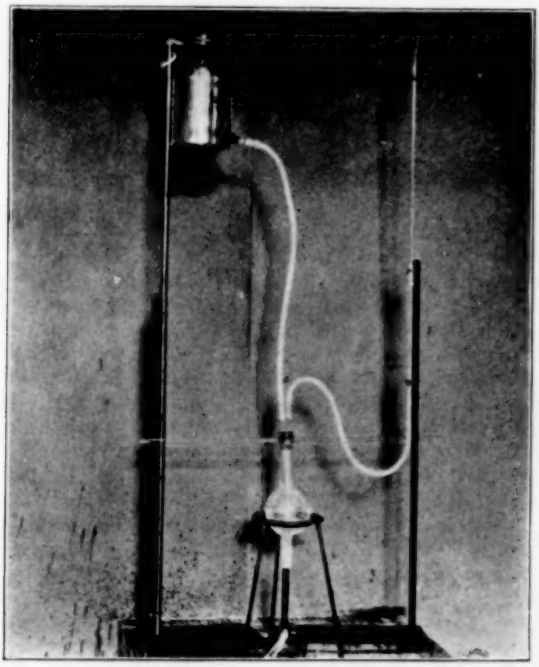


If the equal water levels in the reservoir and geyser tube before the beginning of an eruption are so adjusted that the water rises to within about one inch from the top of the geyser tube, eruptions proceed at regular intervals of about two minutes after the manner of Old Faithful which erupts once every hour. The model geyser as illustrated throws a stream about two feet high at the climax of the outburst as illustrated in the photograph, Figure 3. Preceding the eruption there is a quiet outflow of

water for a second; at the end comes a jet of steam. After an eruption the flask slowly fills from the reservoir and the phenomena are automatically repeated. The reservoir should be quite



large in order to provide a sufficient supply of water for a number of eruptions in succession without lowering the water level too greatly (this increases the violence of the eruption) and also



to prevent appreciable heating of the reserve water by heat conduction from the flask, as this diminishes the interval between eruptions. Ice fragments may be introduced to counteract such a tendency; these will represent the cold ice and snow waters from the mountain supply areas.

In order to make the experiment more realistic for classroom use, it is suggested that a cross-section drawing be made on a

large sheet of cardboard and introduced as a background about the apparatus as illustrated in Figure 1. This will enable students to grasp at once the function of each portion of the mechanism and its relation to the natural conditions. The teacher will find two illustrated pamphlets entitled *Geysers*, by W. H. Weed, and *Geological History of the Yellowstone National Park*, by A. Hague, obtainable for ten cents each from the Superintendent of Documents, Washington, D. C., very helpful in connection with a study of geysers.

While geysers in themselves are perhaps the least significant among geographic phenomena, they are on the other hand only second to volcanic outbursts in spectacular features. Moreover, if properly interpreted, as with this model geyser, they serve to give students a clear insight of the nature of subterranean conditions and their relations to surface features. It is hoped in succeeding papers to suggest other experiments that will help to a better understanding of physiographic phenomena, and incidentally to liven up the course in geography.

THE USE OF SODIUM SALTS IN PURIFYING AND CASTING CLAYS.

In *Technologic Paper, No. 51*, just issued by the Bureau of Standards, Department of Commerce, the results of some work involving the addition of small quantities of sodium carbonate and sodium silicate to clay suspensions are published. Clays, mixed with water, may be considered to consist of a system of fine particles varying from comparatively coarse to very fine grains, 0.003 mm. and less in diameter. It is a curious fact that these fine particles are very sensitive to the influence of small quantities of alkalies, salts and acids, and hence the properties of the clays as a whole are affected to an important degree by such additions. Alkalies tend to break down the grains into still finer particles and to hold them in suspension. At the same time the fluidity of the system is increased so that a separation is possible between the particles capable of greatest dispersion (the clay substance proper) and the coarse particles which comprise the principal impurities. A method of purifying clays is thus suggested. Acids and salts act in the opposite sense, tending to coagulate the particles and to precipitate them. In the casting process, employed in the manufacture of sanitary ware and other clay products, the effect of the alkalies consists essentially in reducing the water content and with it the drying shrinkage, which is essential in preventing the cracking of the ware.

The characteristic effect of the alkalies upon different American clays was studied from several standpoints, particularly with reference to the viscosity of the clay suspensions, the absorption of the reagents, the strength of the treated mixture in the dried state, and the influence of time. The effect of different clays upon each other was also studied.

This publication is for free distribution and copies may be obtained by those interested upon request of the Bureau of Standards, Washington, D. C.

THE BOTANICAL OPPORTUNITY.

By John M. Coulter,
University of Chicago.

It is perhaps timely to call attention to the great opportunity that is just coming to the science of botany. It is the opportunity that presented itself to medicine and to chemistry; that is, the opportunity of great practical service. The scientific handling of plants is coming to be recognized as a universal service, for it is a fundamental factor in solving the problem of food production. This does not mean less science, but more science, for the problems involved are fundamental. The significant fact is that the science of botany will be tied up so closely to the human interest that it will be in larger demand than ever before. We are on the rising wave of the greatest demand for trained botanists we have ever known. I wish to suggest the training that will equip one to take advantage of this great opportunity.

1. *The Synthetic View.*—This new service of botany demands, not the rigidity of separate fields of work, but the co-operation of all fields. Every phase of botany must be focused upon the problems. We have just passed through the phase of the analysis of our subject, splitting it up into its constituent parts. Once a botanist stood for the whole science, but gradually botanists became differentiated into taxonomists, morphologists, physiologists, ecologists, etc., and as each aspect of botany became better defined it became more rigid. As a consequence, taxonomists knew little of any other phase of botany; then morphologists came to know little of taxonomy; then physiologists and ecologists began to segregate from the rest of the botanists and to narrow their interests. All this had the advantage of emphasizing the multiplying fields of botanical activity, and especially it developed technique.

The development of research increased this narrowing process, for it always deals with special regions of a general field. The perspective of each field was kept in view better in the universities than in purely research institutions, for teaching is a great corrective of extreme narrowing. Teaching demands some perspective, while research does not always appreciate the need of it.

At present, however, the movement is all in the other direction. We are passing from the analysis of our subject to its synthesis, and this is called for by the new botanical opportunity. This means that the botanist who remains narrow will be stranded. One must recognize now in every field of botany an important

factor in the solution of problems, for problems are synthetic, and no important problem is shut up within the confines of any one phase of botany. A student must keep in touch with the other work in progress, and must realize what it all means, although, of course, he can specialize in only part of it. A man is expected to regard his own special field as the most important; but if he regards other fields as unimportant, he has blocked his own progress and is moving in ever narrowing circles.

2. *The Botanical Perspective.*—This is becoming more and more extensive, but it must be kept in view, not in its details but in its larger features. The kind of botanical work going on in one's college or university, for example, must be supplemented by some knowledge of the work going on elsewhere. This means such a contact with the literature of the subject that it may lead to an appreciation of important work everywhere. What is going on in the world outside one's own particular territory is the thing to keep in view. This "work elsewhere" is always bristling with suggestions, and a botanist without this perspective is strictly provincial. A man who knows nothing that happens outside of Chicago or outside of the United States would not be regarded as intelligent, even in his own territory. Provincialism in botany, cultivated too much in the past, must be broken up if one is to become equipped for the new opportunity.

One of the most effective ways of "keeping in touch with things" is by attending scientific meetings, especially those that are national in scope. The touch with what is going on, moreover, is not even chiefly obtained from the formal papers at such meetings, but from the numerous conversations concerning work that such meetings make possible.

3. *The Practical Outlook.*—This is the reason for the new botanical opportunity. Botany has come to be recognized at last as of some practical importance; in fact, as the greatest scientific field for community service. Botany and agriculture are no longer distinct fields. Every investigation dealing with a fundamental problem in botany is of possible practical service; and the more fundamental the problem, the wider the possible application. On the other hand, every successful practice of agriculture is of possible scientific suggestion, representing laboratory technique which needs explanation. It seems a long cry from speculations concerning evolution to practical plant-breeding, but the sequence is definite. Speculation concerning evolution led to observation of facts and inferences concerning them; the inferences then began to be tested by experiment; experiment discovered facts of

heredity; and some knowledge of the laws of inheritance suggested the practical possibilities of scientific plant-breeding.

The new opportunity demands that investigation shall include its practical outlook; and it further suggests that just as important scientific problems are presented by plants of economic importance as by any other plants. This entrance of pure science into the field of applied science makes both of them one, in that both become scientific and practical. This is the kind of science and the kind of practice that the new opportunity calls for. In other words, science must have a practical outlook, and practice must have a scientific foundation.

4. *Personal Contact.*—In addition to the intelligent equipment indicated in the preceding paragraphs, the student in preparation for the new botanical opportunity must cultivate a certain kind of personal equipment which I wish to indicate under the captions "personal contact" and "personal equation."

Perhaps the greatest value of scientific meetings is the personal acquaintance they make possible. Long observation has shown that personal acquaintance among one's colleagues is an asset of great importance, both in recognition of work and in opportunity for work. Many a recluse fails in recognition and in position when his work may deserve both. Theoretically, this should not be true; but practically it is true. The ability to cultivate acquaintance may not be natural, but it may be cultivated as a bit of necessary techinque, and invariably the technique presently becomes a pleasure.

5. *Personal Equation.*—There have been more failures in botanical careers through failing in personality than from any other single cause. It is a common remark that advancement in position is not always in proportion to the number of published papers. Botanical training, of course, is necessary, but personal equation is a factor of almost equal importance. If long observation may presume to define the personal equation that succeeds, even in a botanical career, it may be described as kindly, sympathetic and modest. These words are self-defining, and the converse of each of them has blocked the career of many a promising botanist.

To sum up the whole situation, it may be stated that the position a botanist will attain in the new movement that is upon us will depend upon two things almost equally: first, an intelligent and sympathetic appreciation of the general field of botanical activity; and second, a spirit of comradeship that will add personal liking to scientific respect.

WHAT SHALL BE THE CONTENT OF BIOLOGY COURSES IN THE HIGH SCHOOLS OF NEW YORK CITY?[1]

By George C. Wood,

Chairman, Department of Biology, Commercial High School, Brooklyn, New York.

Every competent teacher of biology is fairly familiar with the essential principles of his subject, broad in scope though it be; yet I am inclined to believe that these same teachers often get far afield in following the diverse ramifications of this most interesting subject and forget, in a sense, the derivation of the word "biology." It means—a study of LIFE. Biology is a study of *life* and *life relations*. This life, so far as we are able to discover, is seated in protoplasm. Life functions in different ways. Life has apparent needs. And because life has needs and is seated in a substance known as protoplasm, life tends to express itself, through the medium of this protoplasm, in myriad forms and variations.

Some call these different forms adaptations. Some call them fortuitous differentiations; others call them accidental structural changes which, having appeared, seem to be of no special harm to the organism possessing them and so persist. Marked phenomena of this kind might even be called mutations. Still others seem to place a purposeful or teleological interpretation upon the whole series of phenomena expressed in form and structure. This question I will not discuss here, because the situation might become heated, or even acrimonious. To sum up, we find a great range of differentiation between animals and between plants and yet in spite of this we have a fundamental substance common to both plants and animals and to all the myriad differentiations of each group of living things—*protoplasm*.

At the risk of making my remarks seem commonplace, I want to reiterate that our whole problem of biology teaching resolves itself into two great subdivisions, which, unfortunately are problems still: 1. Life—its functions and needs; 2. Life's outward expression through protoplasm in structural adaptations or, if you please, differentiations.

But there seems to be an intimate relation between these two propositions and one common ground where both seem to meet and that is in the cell, as the unit of plant and animal structure. I believe that the fundamental conception of all biological teach-

[1]Read before the fall meeting of the New York Association of Biology Teachers at the Washington Irving High School, 30 October, 1914.

ing is primarily dependent upon the cell, its contents and its functions. Not the cell as a cell, understand me, but the cell as *the unit of plant and animal structure*. Amœba, frog, insect, mammal, man, yeast, rose, oak, are all resolved into an intelligible whole when the structure and the substance common to them all is fairly comprehended. With the concept of the cell as one milestone in the biological journey of life, how attack what is to follow? Shall we take this great problem and phenomenon of differentiation as the basis for our biological study? If so, where do we begin? You say anywhere, so long as you illustrate the fundamentals of the subject. Very good. But if you begin anywhere, you end anywhere. In short, where do you get off? What is the end in view? Is it to discover principles or to discover the unending number of differentiations? If it is to discover principles, it is a slow and ineffective procedure and the pupil will finally be told the principle by the teacher to save him from being lost. If the aim is to beget wonder at the myriad forms of life, it is a reckless waste of energy and ends in intellectual chaos for the pupil.

To make the proposition concrete, I would say that the best way to make an efficient architect would be to show him buildings constructed by architects, and then after he had learned something of the whole structure in its entirety, let him proceed to find out how it is made by taking it to pieces, figuratively speaking, and then have him put it together again. But some well-intentioned persons would have us show the embryo architect a window frame, a baseboard, a sill, a door and a nail and then say—"Go to, now, and construct your building."

Again, should the *subject* be taught or should the *pupil* be taught, with a view to his fundamental needs and functions as an animal and then as a human personality? Your ordinary pupil has no essential relation with the madreporic plate or the maxillipeds or even the caudal fin, but he most emphatically does have a close relationship with the way each of the animals represented by the above-named appendages gets its food, breathes, protects itself and reproduces, for it may be a very important matter for him to know these things—and to allay the immediate objections of those who say that I am now mercenary, I will say that there is just as much disciplinary value in studying fundamental functional processes in common living things as in studying incidental structural adaptations of forms infrequently met, particularly when such forms are studied for their own sake.

In the study of the functions and needs of living things you may begin with any or all of them in any living organism. You may choose and when you have exhausted the possibilities of that organism (taking into consideration, of course, the capabilities of your pupils) you have worked out a scheme which will be at once a working and invariable formula for every living thing with which the individual will ever come in contact during his whole lifetime. To illustrate: Many boys whom I have had the opportunity of teaching have told me that when they went to the Bronx Zoological Park, for instance, the first thing that came into their minds as they entered the lion house, or the bird house, etc., was—What are the life needs of these lions, or birds? How do they eat? What do they eat? How do they breathe? How do they protect themselves from their enemies? They were naturally forced to a consideration of the structural differentiations, but with pleasure and satisfaction and profit.

Thus the fundamentals of life become apperceiving groups. They are pegs upon which the future readings of the individual will inevitably hang; they are the centers around which all future biological interests will swing; they are vortices which will swallow up and assimilate all heterogeneous biological facts of the future.

By the first method you begin in a maze and end in a maze of structural differentiations. The result is a very marked lack of the power of generalization. You begin with an exception to a general rule. How can you expect to formulate valuable principles by that method?

Suppose you introduce the pupil to the study of the similarities and differences between the mouth parts of the grasshopper and the honey bee. A laborious process and valuable in some respects, but in my estimation, it is a case, to reverse the commonly accepted proverb, of straining at a camel and swallowing a gnat. After days of study the pupil is finally told that one is a biter and the other is a sucker, and that is all there is to it.

Now, on the other hand, if one watches a grasshopper eat grass and a bee suck nectar or a plant louse suck plant juices, one is convinced that they eat differently, and that consequently they *must* be built differently to eat in these ways. Just *how* they are built differently is not so important a matter. One can almost infer that, but the thing we want here is the fact that *they*, like *ourselves*, need food to feed those cells, which the pupil has previously studied and because they need the things that *we need*,

the human element comes in—sympathy and protection for the animal which benefits us and a knowledge of how to control or rid ourselves of the animals which injure us.

Interest never flags in this procedure because function is dynamic, while structure is static. You begin with the principles and end with their application in a clean-cut, vital, practical way. The results are enduring.

Now, I do not want to be misunderstood to the extent that you infer that I am opposed to all structural study. That position would be ludicrous and untenable. But I do mean to say that when a study of function precedes structure, not so much structural work is needful and what is undertaken is much more profitable to the pupil.

When structure *follows* function, it is devoured with enthusiasm previously generated. The pupil wants to know the answers to the questions—What? How? and Why? And this attitude is just the one you ought to be seeking. The work at this point will appear more vital to the pupil because—1, it will allow him to organize his own ideas; 2, it will provoke him to serious thought; 3, it will develop his limited personality; 4, it will increase his powers of expression; 5, it will give him growing confidence in himself; 6, it will end in real accomplishment which is the first flower of methodical and enthusiastic effort.

By this method (to use a parallelism) the boy who desires to become a locomotive engineer is first shown steam and its power and is then put to work to find out how the locomotive is constructed to best use that power. But some persons would have us believe that to turn out the best engineers, you must give the pupil the parts of an engine, and by putting them together, thereby discover the nature of the power which is supposed to run it.

Nobody has yet written out an ideal course in biology, and I am convinced that nobody ever will. But I am further convinced that we have moved along far enough to come to some unanimity of opinion as to what things are *vital* to such a course. This means that we should strive to gain the most comprehensive and practical view of organic existence in its relation to man within the time allotted to us for that purpose.

If this viewpoint is tenable, then I may first venture to say what the biology study in our schools should not attempt:

1. It should not attempt to cover the whole field of biological knowledge.

2. It should not strive to cover a large number of forms for

the purpose of illustrating evolution. This is not vital in the present-day attitude to this fact.

3. It should not attempt to make histologists from youths in knickerbockers and Windsor ties.

Then what should a course in biology attempt to do?

1. It should give practical and cultural teaching in the immature years.

2. It should enlarge the life outlook of the growing boy or girl.

3. It should greatly develop the *mental constructive ability* of the average pupil.

4. It should seek for breadth rather than depth in the treatment of life's principles.

5. It should treat of life as it now is, with a view to life as it may become, through the improvement of its environment.

6. It should attempt to make the pupil a good animal—and then a good and useful citizen.

How can a course in biology be so outlined as to come nearest to a realization of these six goals? I believe that such a course should include:

1. A definite and comprehensive concept of the cell with its contents and its functions as the unit of plant and animal structure.

2. A study of a fungus with its practical human applications.

3. A study of a green plant with its practical human applications.

4. A study of one animal (preferably an insect) for the purpose of showing the identity of many of the processes in plants and animals with emphasis upon the need of food and its practical human applications.

5. A study of the fish (if possible) with emphasis *only* on its method of breathing.

6. A study of the bird (if possible) with emphasis *only* on its method of reproduction.

7. A study of a lower mammal (if possible) with emphasis only on its method of reproduction.

8. A thorough and practical study of the human body with great emphasis upon hygiene.

This method of attack and this content makes biology, it seems to me, a study of life—not a study of botany, zo-ology and human physiology. It is an attempt to apply the principles and functions of living things to the human mechanism with a view to its proper conservation by proper habits of hygiene. The supreme goal

of all first-year biology teaching is, I take it, under present conditions, the conservation of the individual and his preparation for the most efficient and wholesome service to the community of which he forms a part.

I am fully aware that nothing I have here said is new—there is nothing new in the subject. Our problem is not one of *construction;* it is rather one of *emphasis and elimination*. And in my experience the only profitable and at the same time practical *core,* is that of the *functions* and the *needs* of living things and the best methods by which those functions are guaranteed and those needs are satisfied.

THE VALUE OF A GREENHOUSE TO HIGH SCHOOL BOTANY.

By A. F. Ewen,

3411 Pestalozzi St., St. Louis, Mo.

Is a greenhouse of sufficient value to the work of high school botany to justify the added expense of construction, equipment, and maintenance? The answer to this question must be left to your decision after a discussion of the work that is carried on within the greenhouse.

The subject, botany, as it is now taught, deals with two broad phases of plant life, that which is academic, treating the biological principles of plant life, and that which is economic, treating the value of plants to man, their development and care. In order to secure satisfactory work in either phase, the greenhouse is indispensable.

I venture the statement that there is not a teacher of botany anywhere, but that is utilizing sunny windows, attempting as far as facilities exist to do the very things in a limited way that they feel should be done in a well-lighted, properly heated and ventilated greenhouse. The teacher of chemistry has his supplies in labeled bottles on the shelves, the teacher of physics has his apparatus in the case, but the teacher of botany must have most of his material alive and growing, and without the greenhouse the best that he can do is but a poor makeshift. Walk into a laboratory with no greenhouse attached and see the few experiments fixed to show the work of photosynthesis. The teacher is doing the best he can with the short period of sunshine at his

disposal. From here go into a greenhouse where pupils are making observations and measuring results from the experiments they have set up. Is there any comparison in the interest and enthusiasm of the two groups of students?

As it is in the example just given, so will it be with all the experimental work in plant physiology. The use of light, heat, air and moisture can be obtained to show best results only in a greenhouse.

The development of the bud into an open flower can be successfully watched as it takes place in greenhouse culture. The action of the flower as it matures its stamens and pistils can be noted from day to day. The work of pollination and fertilization is carried on and the results as shown in nonpollinated flowers observed. The development of fruit and seed is watched and results tabulated. Germination of different seeds with observations of the manner in which the seedling removes itself from the seed coats, how it breaks the soil, what parts of the seed develop into certain parts of the plant, the use it makes of the cotyledons, and the manner in which it elongates the stems, are all made, and are of much interest to the student.

The use of the greenhouse from an economic standpoint may be illustrated by the work we have the students do in connection with the planting and growing of plants. The first work in this line is the study of the preparation of soils. Our St. Louis soil is a heavy clay soil, somewhat acid in its character. This soil must be enriched with fertilizer, made porous with sand or ashes, and rendered neutral with lime. This work the students do in the greenhouse. In October or early November, bulbs of the narcissus, tulip and hyacinth are planted in pots. These pots are then buried in the ground until the middle of December when they are taken up and forced into bloom in the greenhouse.

During the winter months much can be accomplished by having the pupils grow in pots the various economic grasses, wheat, rye, corn, oats, millet, etc., together with other economic plants, such as flax, cotton, etc.

In the fall, cuttings are made of geraniums, begonias, etc., and in the spring pupils experiment in grafting and budding. By planting all the seeds from one plant, variation is studied. By watching the crowded plants in a pot develop, the struggle for existence is seen. By a study of the algæ, elodea, and the feather foil growing in the aquarium; the mosses, liverworts, and ferns growing in the shade under the benches; and the begonias, ge-

raniums and Celosias growing in the bright sunlight, we have no difficulty in showing adaptation to environment.

The people of South St. Louis, where the Cleveland High School is located, are fond of flowers and gardens. There is scarcely a yard but has its little garden plot. In the greenhouse we shall germinate many of the plants that will be transplanted to these garden plots, the student bringing the seed from home and germinating it at school. Last year, we offered a prize for the best asters grown from seed which was germinated in the greenhouse.

The tendency ofttimes is to make the greenhouse a repository for ornamental plants. This is a mistake. By far the greatest amount of space should be given to the plants which the pupils are raising and thus are personally interested in.

The plants that are kept in the greenhouse should represent as large a variety as possible. I want algæ, mosses, liverworts, ferns, palms, and a few of the common greenhouse plants. In addition, I would have economic plants, those from which textiles, perfumes, condiments, medicines, oils, resins and gums are secured.

The greenhouse offers the opportunity of teaching the care that indoor plants should have—the method of fighting insect pests, the watering and ventilating needed by growing plants. In fact, it offers the opportunity of stepping from the laboratory, where pupils work, to a laboratory where plants are working, and thus provides for the teacher concrete examples for his laboratory and classroom work.

WELLS MORE THAN A MILE DEEP.

The deepest well in the world is in South Africa, over 8,000 feet deep; another deep well is in Upper Silesia, in the German Empire, 7,350 feet deep. A well in the United States which may go deeper according to the United States Geological Survey is about fifteen miles west of Pittsburgh. This well was 7,174 feet deep in June. Some gas and oil were struck in the upper part of the well. Between the depths of 6,830 and 7,100 feet, rocks bearing rock salt and salt water were encountered. The temperature in this well at the depth of 6,775 feet, as recently determined with great accuracy, is 145.8 degrees Fahrenheit.

At Derrick City, McKean County, Pa., near Bradford, there is a well 5,820 feet deep, which is probably the second deepest well in the United States. Another deep well is in Kanawha County, W. Va.; it is 5,595 feet deep. Deep-well drillers in this country of course employ the most improved and effective rigs, but one of the most remarkable of wells, reaching a depth of 3,600 feet, was drilled for petroleum in western China by means of such crude appliances as a cable made of twisted strands of rattan.—*Journal of Geography.*

A QUESTIONNAIRE IN CHEMISTRY.

By Erle M. Billings,
Rochester West High School, Rochester, N. Y.

In this day of commercialism, it often seems necessary to glance at every activity from the commercial standpoint. So, we may well ask, will a knowledge of chemistry prove of any value to the would-be mechanic, farmer, business man, or ordinary laborer? It seems to the many eminent authorities of whom the writer has asked this very question, that the answer is without doubt in the affirmative. Everything about us, paper, cloth, wood, food, air, plants and earth, are intimately associated with chemistry. It is almost impossible to name anything about us with which the science of chemistry is not concerned.

Chemistry in high schools should be composed of varying courses. These should be of such a nature as to discipline the mind and to give a step toward a better understanding of the chemical principles upon which occupations depend. So in a hundred ways chemical knowledge is most valuable to the high school girl and boy, especially if he or she does not desire to take a university course. Chemistry will come to be looked upon in the same light as spelling was of old. The writer says this because in almost every bulletin, paper, magazine and report, articles on pure food, paints, fertilizers, medicines, etc., are listed. Some knowledge of chemistry enables one to grasp and understand far better the contents of these. Otherwise, the almost indispensable and valuable information given is of no value. A little chemical knowledge is often the means of saving many dollars. The reverse is equally true. In order that chemistry may serve its best and most efficient use, there should be not only one kind (preparation for college) but many kinds taught.

During the last twenty to twenty-five years, chemistry has not gained in percentage but has actually lost. The writer believes this would be expected if we would keep in mind that the great rapidity of advancement in all capacities of civilization has caused us to swing the commercial pendulum with a large amplitude of vibration. So, physical sciences in high schools have been overlooked in the last years.

During 1909-10 nine and thirty-eight-hundredths per cent of the total number of students attending private schools were taking chemistry. In the public schools the percentage dropped to six and eighty-nine-hundredths per cent. Why this drop? Per-

haps, because of better laboratory apparatus in the private school, and because a far larger per cent complete the four year work.

During the early part of the year 1914, the writer sent out a questionnaire to several of the leading cities in this country. Replies were received from most schools where the questionnaire was sent.

The population of the schools responding to the questionnaire was over 20,000 pupils. 2,200 of these were taking chemistry. Twenty-four men and four women were engaged in teaching the subject. The table on page 136 will show the numerical tabulation of the questionnaire's results.

It is noted that very few high schools offer courses which require chemistry for graduation. Houston, Texas, requires chemistry for all courses except the commercial. Wilmington, Del., has a general course which requires the subject. Broadway High, Portland, Ore., requires chemistry in its domestic science course. Los Angeles High School and John Marshall High School, Richmond, Va., require it in their scientific course. Scientific and manual training courses in Helena, Mont., necessitate chemistry. Boys' industrial course offered at Burlington High demands chemistry.

Baltimore City College; English High at Boston; Hume-Fogg High School, Nashville; and John Marshall High School, Richmond, have no separate chemistry department but have chemistry under the science department. Broadway High, Portland; Mobile High, and Burlington High have the same arrangement.

Houston, Texas, and Wilmington, Del., are the two which possess a supervisor of science. None have city supervisors of chemistry. Many cities have supervisors of writing, English, mathematics, etc., but science seems to be forgotten. Why is it? Is it because there is so much jealousy between different branches of science, i. e., biology, geography, physics and chemistry? Is it not possible the broadening gained in scientific study should lead us chemistry teachers and other science teachers to a closer union, to closer realization of what is valuable for the different branches? Less duplication of apparatus and subject matter would result if our high school sciences of today were closely linked and thoughtfully planned from the kindergarten to the end of high school. Uniform system of note-keeping which in itself is no small matter would result. Think of how much time of the student is spent each term in acquiring a different system of recording his notes. Does this not lead the student to think it

SUMMARIZATION OF IMPORTANT DATA

School	Number in School	Boys	Girls	Number in Fourth Year	Year From Which Chem. Students Come	Courses which Require Chem. for Graduation	Number of Chemistry Students	Number of Men Teachers	Number of Women Teachers
Baltimore City College	1,060	1,060		200	3 & 4	0	136	4	0
Boston English High	1,900	1,900		200	4	0	275	2	0
Houston High	1,277	500	777	250	4	All Except Commercial	125	1	0
Minneapolis West High	1,501	667	834	209	3	0	147	1	1
Wilmington High	930	375	555	85	2,3&4	General 91	1	0	
Portland, Ore., Broadway High	1,617	754	863	264	3 & 4	Domestic Science 82	1	1	
Los Angeles High	1,950	800	1,150	450	4	Scientific	350	2	2
Nashville, Tenn., Hume-Fogg High	1,200	500	700	250	2 & 3	0	140	2	0
Richmond, Va., John Marshall High	1,300	400	900	60	3	Scientific	90	1	0
Mobile High	600	200	400		4	0	16	1-Part Time	0
Brooklyn Boys' High	2,200	2,200	0	0	2 & 4	200-2nd Yr. 100-4th Year	2.5	0	
Helena High	285	116	169	34	3	Scientific and Manual Training	18	1	0
Burlington, Vt., High	429	206	223	65	4	Boys' Industrial	21	1	0
Detroit Central High	2,700	1,300	1,400		3	0	356	3	0
Rochester, N. Y. West High	1,100	500	600	150	3 & 4	0	53	1	0

matters not which way some things are done, for everyone seems to have a system of his own? The inefficiency of the affair is self-evident.

Boys' High of Brooklyn and English High of Boston, each give two courses in chemistry. One of these prepares for college, the other is informational. Wilmington High gives a household chemistry besides the general course. Rochester West High, Portland, Ore., and Burlington High do the same. Detroit Central adds an industrial course, while Baltimore adds qualitative chemistry to the above two.

In general, the replies show a marked belief in offering a different course to girls than to boys.

To the question: Would you be in favor of chemistry being required the last two years and then offering more courses? Dr. Leslie H. Ingham of Baltimore says: "No, but I think it would be good to have more advanced elective courses, if possible"; Los Angeles High answers: "We have a college department which offers several chemistry courses"; Hume-Fogg High of Nashville says "No;" John Marshall High of Richmond answers: "Yes, if time permitted"; Mr. Frank S. Spaulding of Boys' High, Brooklyn, says: "No, I would favor a required informational course in second and third year, followed by elective courses"; Mr. Harris of Mobile, reasons: "This would tend to specialization in high school work, which here I do not deem advisable. It would work where there is a demand for special chemistry training." Helena would require one year and then offer elective courses. Burlington would not have it required and Detroit Central says: "No."

A few more than half the replies indicate a desire to have the student possess a knowledge of physics before beginning the work in chemistry. Smith and Hall in *The Teaching of Physics and Chemistry* say: "the study of either subject is bound to hasten the process of acquiring the other, but the precedence of physics is the more economical arrangement, since it will but little diminish the speed with which physics may be acquired, while greatly accelerating the progress of the pupil in chemistry." It seems as though more of us ought to agree with Smith and Hall.

All but Mobile say that they commercialize their courses more than is done in the text.

It was a surprise to see so few teachers using their own quota of experiments. It seems that the laboratory is an excellent

place to connect the community interest with the subject matter of chemistry. The laboratory is the live wire and should not be grounded by using the experiments of some one not in touch with the community.

The recitation and laboratory periods seem to be practically the same the country over. Three recitation and two double laboratory periods is the prevailing scheme. Periods average forty minutes.

Demonstrating is done in the classroom, but little is done in the laboratory. Right here is a chance for debate. Many believe that teachers are prone to talk too much, and they would have us drill the student on the literature of his text, which in the vast majority of cases is meagre in its illustrations and applications. Cannot a demonstration in the classroom be of more value than a dense array of descriptive material? The chemistry of the laboratory is the only real chemistry.

Los Angeles; Hume-Fogg, Nashville; and Mobile High do not have their students write up notes while in the laboratory. Many others simply have the students make a rough draft of notes in the laboratory and then write them in detail later. The rest require complete writing of notes in the laboratory. Notes are finally inspected, as a rule, after school.

Nearly all say there is no time to do work for themselves. How are teachers going to be able to keep abreast with the advances of modern science if they are overburdened with routine work?

The salary of the head of department or teacher in charge averages $1,748 a year, the extremes being $2,650 and $1,200.

All teachers who replied possess a college or university degree. Few possess doctorate degrees and some have the master's degree.

The writer wishes to thank Mr. Harry A. Carpenter, Head of Chemistry Department, Rochester West High School, for much valuable assistance given in the preparation and carrying out of this questionnaire.

REPORT ON MAGNESITE.

The annual statement of the United States Geological Survey on the production of magnesite in 1914, now available for distribution, shows an increase over 1913 of seventeen per cent, 11,293 short tons of crude magnesite, valued at $124,223, having been produced or sold and treated in the United States during the year.

THE HIGH SCHOOL PHYSICS LIBRARY.

By E. J. Rendtorff,
Lake Forest, Ill.

At the last meeting of the affiliated schools of the University of Chicago, a committee was chosen to select the books most suitable for the high school physics library. This committee consists of Mr. E. J. Rendtorff, of the Lake Forest Academy, Chairman; Mr. E. E. Burns of the Medill High School and Mr. W. E. Tower of the Englewood High School, Chicago.

The committee endeavored to select books intended exclusively for the use of the student and not primarily for the teacher. An attempt was made to get away from the textbook type of library, that does not appeal to students, and to substitute books of a more general and popular type, that pertain to the science of physics.

Practically every teacher complains that the students do not manifest any real interest in physics, that they will not use the school libraries and that the subject is unpopular. After having examined many school libraries, the reason for the second charge becomes evident. Few schools present even an apology for a physics library. When a collection of books is found, they generally resolve themselves into a series of antiquated, abstruse textbooks that former teachers or patrons have, with mistaken kindness, contributed to the institution after a thorough house cleaning in their own private libraries, and of a general assortment of elementary textbooks presented to the teacher for the purpose of introduction as a class text.

Occasionally, an appropriate book is found hidden amongst a bunch of trash, so as to escape attention. No wonder that the student does not use the library. Fortunately, he has an average sprinkling of common sense and an idea of the eternal fitness of things.

The neglect of the high school library is prevalent in practically every secondary school. Its development has seldom been undertaken with any seriousness. We have simply assumed that the students will not read and that the fault was entirely theirs.

When the work of the selection of appropriate books was assumed by the committee, it was found extremely difficult to obtain the necessary help from their fellow teachers. Some fifty personal letters were sent to various teachers, asking for the

names of appropriate books. Some few books were recommended by practically everybody, although they contained but little of merit. They belonged to the fashionable set. About one-half of the books recommended were utterly inappropriate for high school use.

The various publishers were also appealed to and in some cases they donated books that their experience proved to be popular.

In this way, and through the personal investigation of the committee, the names of some three hundred books were secured. After the antiquated books, and those out of press were eliminated, there remained some 240. An attempt was now made to purchase all the recommended books, for personal study, so that none would be placed on the final list through hearsay. Some few publishers also contributed their publications for the good of the cause. Some 160 books were collected, over one-half of which were thoroughly inappropriate and in many cases useless. After this experience, with what was assumed to be the better books, the committee began to hesitate about purchasing what remained.

A complete list was now made of all the recommended books and some one hundred copies sent to various teachers, with the request to mark them as follows: A, when of exceptional value; B, when good; F, when fair; and D, when poor in subject matter, general treatment, or beyond the ability of the high school student. A request was also made for the names of any books of exceptional merit not already on the list.

The result of this attempt was discouraging. Comparatively few lists were returned, the average teacher failed to contribute anything new, while the estimates of some well-known books varied from A+ to D.

After allowing for the expected difference of opinion, the varied environmental conditions and special hobbies, the conclusion seems to be that the entire subject is in such a chaotic, unorganized condition that an appropriate selection can be made only by a general appeal to the entire teaching profession.

The committee has therefore decided to publish its selected list as it now stands, with an urgent request to every teacher, student and layman to contribute additional books that from personal experience are known to be of exceptional value and interest to the high school student. These books are to be of such type as the average student will read, not under compulsion, but voluntarily and with pleasure, because of actual interest and in-

trinsic value. They should be books with the proper punch to them.

It is the intention of the committee to have at least one exceptional comprehensive textbook on general physics, one table of physical constants, a good general book on formulas and recipes and at least one good textbook on each of the various departments of physics—mechanics, heat, sound, electricity and magnetism, and light. The remaining books should mainly be of the popular type, free from the general textbook idea, but correlated to the subject of physics.

SCHOOL SCIENCE AND MATHEMATICS has kindly consented to publish, in its next edition, whatever good books are recommended, in addition to those of this article. For the benefit of our students and our schools, it is desirable that this contribution be large and well-selected. The committee can then secure these books, examine them carefully and finally present a list that will be of lasting benefit to our students, teachers and schools.

The need of an appropriate list of books is very acute. It is probably the most serious question to be solved by our science teachers. Practically every teachers' journal laments the lack of interest in science work and gives statistics illustrating that it is rapidly becoming unpopular and is being superseded by other studies. Is the reason for this not perhaps because we do not foster the required interest, but feed our students only with dry textbook work and fail to supply them with the appropriate and desirable reading matter?

Allow me to outline my personal experience. For fifteen years I ignored and neglected our library. We, of course, had a collection of books, absolutely inappropriate, but not far different from that of other schools. My students never read outside books and I made no attempt to have them do so.

Last spring I placed in our classroom a series of some one hundred books, every one of which was at least good and full of actual interest to the high school student. At first I said nothing about these books and they were not read. The students had been stung before and were on their guard. After about one month I would occasionally refer to some book in our library and casually suggest that it might make interesting reading. A sickly grin would, as a rule, be the only response. I next selected some half dozen books appropriate to the subject then being reviewed in class, held them up for inspection, made a few remarks about their contents and general value, and inquired if

anybody in the class would care to read them. As a special favor, one student in a moment of absent-mindedness, consented to take a book—Domville-Fife's *Submarine Engineering of Today*—a book that had not been recommended to the committee. Two days afterwards the book was returned with the characteristic remark: "Say, that's a corker, have you anything else by the same author?" I told him no, but that there were others "just as good." He has since found that to be true and now reads on an average about one book per week.

This started the ball rolling and the trouble now is not in getting books read, but rather in limiting them, so as not to interfere with the regular lessons. Over fifty per cent of the students now read outside books regularly. When the library books were collected just before the Christmas holidays, it was found that over eighty-five per cent of the students had one in their possession.

The trouble is not with the student, it lies instead with the teacher and library. I consequently repeat and maintain that the selection of an appropriate list of our best books is a crying need, and that it is to the advantage of every teacher to contribute what his or her experience has found to be of exceptional interest and value. Since last September, I have received seventeen letters requesting our final list.

Our list is not yet complete and will be revised and enlarged. Some sixty books are now being considered. At present the following books are recommended by the committee as appropriate for the high school student of physics:

1. GANOT—*Physics.*
2. JAMESON—*Elementary Mechanics.*
3. STEWART—*An Elementary Textbook of Physics (Mechanics).*
4. MORLEY—*Mechanics for Engineers.*
5. *Encyclopedia of Formulas (Munn & Co.).*
6. HENLEY'S *20th Century Book of Recipes.*
7. KAYE AND LABY—*Physical and Chemical Constants.*
8. HOPKINS—*Experimental Science.*
9. BERGET—*Conquest of the Air.*
10. HILDEBRANDT—*Airships Past and Present.*
11. TURNER—*Aerial Navigation of Today.*
12. CORBIN—*Mechanical Inventions of Today.*
13. WILLIAMS—*How It Works.*
14. WILLIAMS—*How It Is Done.*
15. WILLIAMS—*How It Is Made.*
16. GIBSON—*Scientific Ideas of Today.*
17. DOMVILLE-FIFE—*Submarine Engineering of Today.*
18. CORBIN—*Engineering of Today.*
19. KING—*Physics in Agriculture.*
20. BOYS—*Soap Bubbles.*
21. WILLIAMS—*The Romance of Modern Invention.*
22. GIBSON—*The Romance of Modern Manufacture.*

23. WILLIAMS—*The Romance of Modern Engineering.*
24. WILLIAMS—*The Romance of Modern Locomotion.*
25. WILLIAMS—THE WONDERS OF MECHANICAL INGENUITY.
26. BOND—*With Men Who Do Things.*
27. LODGE—*Elementary Mechanics.*
28. OGDEN—*Heat.*
29. TYNDALL—*Heat as a Mode of Motion.*
30. BOLTON—*Evolution of the Thermometer.*
31. RANDALL—*Heat.*
32. THURSTON—*History of the Growth of the Steam Engine.*
33. PAGE—*The Model Ford Car.*
34. PAGE—*The Modern Gasoline Automobile.*
35. FAUROTOE—*How and Why of the Automobile.*
36. SHENSTONE—*Manual of Glass Blowing.*
37. JACKSON AND JACKSON—*Elementary Electricity and Magnetism.*
38. TIMBIE—*Elements of Electricity.*
39. THOMPSON—*Elementary Lessons in Electricity and Magnetism (New Edition).*
40. GIBSON—*The Romance of Modern Electricity.*
41. GIBSON—*Electricity of Today.*
42. HOUSTON AND KENNELLY—*Electric Arc Lighting.*
43. HOUSTON AND KENNELLY—*Electric Incandescent Lighting.*
44. HOUSTON AND KENNELLY—*Magnetism.*
45. HOUSTON AND KENNELLY—*Electric Heating.*
46. HOUSTON AND KENNELLY—*The Electric Telegraph.*
47. HOUSTON AND KENNELLY—*The Electric Telephone.*
48. MORGAN—*Wireless Telegraphy and Telephony Simply Explained.*
49. COLLINS—*Manual of Wireless Telegraphy and Telephony.*
50. PIERCE—*Principles of Wireless Telegraphy.*
51. MORGAN—*The Boy Electrician.*
52. HALL—*The Young Electrician.*
53. WALMSLEY—*Electricity in the Service of Man* (2 Vols.).
54. GIBSON—*Autobiography of an Electron.*
55. DUNCAN—*The New Knowledge.*
56. RAFFETY—*An Introduction to the Science of Radio-Activity.*
57. SODDY—*Interpretation of Radium.*
58. HAWKINS—*Electrical Guides* (8 Vols.).
59. HAWKINS—*Electrical Dictionary.*
60. TYNDALL—*Sound.*
61. CROSS—*Geometrical Optics.*
62. THOMPSON—*Light, Visible and Invisible.*
63. NEWALL—*The Spectroscope and Its Uses.*
64. TALBOT—*Moving Pictures, How Made and Worked.*
65. DERR—*Photography for Students.*
66. HOUSTON—*The Wonder Book of Light.*
67. GIBSON—*The Romance of Modern Photography.*
68. JONES—*Photography of Today.*
69. GIBERNE—*Sun, Moon and Stars.*
70. BALL—*The Story of the Heavens.*
71. BURNS—*Story of Great Inventions.*
72. FOREMAN—*Stories of Useful Inventions.*
73. CAJORI—*A History of Physics.*
74. BUCKLEY—*A Short History of Natural Science.*
75. WILLIAMS—*The Story of 19th Century Science.*
76. LODGE—*Pioneers of Science.*
77. GARNETT—*Heroes of Science.*
78. JONES—*Thomas Alva Edison.*
79. FIELD—*The Story of the Atlantic Telegraph.*
80. CASSON—*The Story of the Telephone.*
81. CASSON—*Cyrus Hall McCormick.*
82. ABBOT—*Panama and the Canal.*
83. COCHRANE—*The Wonders of Modern Mechanism.*

84. BAKER—*The Boys' Book of Inventions.*
85. WHITE & HARPER—*The Aeroplane.*
86. VERRILL—*The Gasoline Engine.*
87. PUTNAM—*The Gasoline Engine on the Farm.*
88. PAGE—*Motor Cycles.*
89. REETZ—*Electroplating.*
90. RADCLIFFE & CUSHING—*Telephone Construction.*
91. MCCORMICK—*Electricity.*

The Committee on a High School Physics Library, consisting of Messrs. Rendtorff, Burns and Tower, has been busily engaged for over a year in preparing the above list of books. Yet they realize that they have been unable to get in touch with all of the literature on the subject. The Editor of this Journal is asking all people who read this article if they will not kindly send to him at once the name, name of author and of publisher, date of publication, and price of any book on physics which they think ought to be added to this list. Such a list of additional books will be published to supplement the above, and will appear in the next issue of this Journal.—EDITOR.

THE CLASS IN LOCAL INDUSTRIES.

BY GEORGE W. FRIEDRICH,
High School, Superior, Wisconsin.

A year ago, upon the suggestion of Mr. W. E. Maddock, Superintendent of Schools, a class was organized in the high school for the purpose of studying the industries of Superior and vicinity. The work was placed in the commercial course of the school curriculum.

The class is fortunate in having a wealth of material from which to select. The industries of Superior are many and varied. They comprise the iron ore docks, blast furnaces, steel mills and foundries; coal docks, briquette plants, coke ovens with auxiliary industries and carbide furnaces; grain elevators, flour mills and a linseed oil factory; lumber yards, sawmills and wood manufactories; electric power plants, transforming stations and telephone exchanges; a large harbor and ships; railroad terminals and repair shops, together with many minor industries. Though classes organized for this study in other cities may not have such a happy variety of material, still all towns and cities have enough to make the course decidedly useful.

The educational values are manyfold. The first and most important is that of a ready acquaintance with the industrial units of the home community. It was found that less than ten per cent of the class had visited one-tenth of the fifty or more institutions before they had entered the class. Perhaps less than

five per cent of the citizens of Superior have visited more than one-tenth of the local industries. This estimate would probably hold true for any city over 25,000 in population.

The students, with a few exceptions, have no foundation in science. The subject matter is so treated that it could well be substituted for a general science course. The study of the harbor, soil and climatic conditions are lessons in physiography and biology. The blast furnaces, steel plant and coke ovens are lessons in chemistry. The electric power plants and manufacturing institutions are lessons in physics. Statistics and transportation are lessons in commercial geography. The discussions on supply and demand of the raw and finished products are lessons in economics. The written accounts in the notebooks are lessons in English. Vocational guidance is one of the great values of the course. One will touch on many other phases of education in a natural manner.

To illustrate the method of approach to the study of these industries, the iron group will be outlined. The locations of the iron centers are noted and compared. Then the iron ranges and ore transportation to the docks are studied. The class then visits the ore docks, noting the emptying of the ore into the pockets and the orepunchers at their work in and about the pockets. Here the students leave the dock and board the boat, where a better view of filling the hatches is obtained. Questions are asked in regard to the destination of the boat, number of pockets, capacity, number of men employed, wages, business prospects and possibilities for advancement. The docks are then discussed in the classroom, and a full account of the industry is written.

A trip is then made to the Zenith blast furnace. The charging of the furnace with ore, flux and coke, the drawing off of the slag and iron, the molding of pigs, and loading onto cars by means of electromagnets are noted and explained. Then, returning to the classroom, a simple explanation of the chemical changes involved and methods employed is given. Again an account is written. A trip to the Duplex foundry is next made. There the piles of pig iron and scrap cast iron, the furnaces, molds, pouring off of iron, the casting, smoothing and shaping of the castings in the machine shop, the wood department, and, finally, the assembling and shipping departments are observed and explained. The last trip of this series is to the steel mills. There, the steps are followed in a logical manner, simply explained and written up. First the coke ovens are investigated. Then the

charging of the blast furnaces and drawing off of the slag and the molten iron are noted. The slag is sent to the mills and the iron to the open hearth furnaces. From here the class follows the steel to the roller and rail mills. The last visit is to the power house where the huge gas engines are seen in operation.

The class meets the seventh and eighth periods. The last period is often used as a study hour. A full discussion of the last trip and introductory remarks upon the next trip are given. Simple experiments which pertain to the material and energy are made. One trip is taken each week, the excursions averaging about three hours in length of time. Of all the excursions made, only two encroach upon the time of the other school classes.

A news-clipping bureau was established. The class subscribes to two daily newspapers, and in addition the pupils are expected to read the articles pertaining to the industries in the newspapers taken at their homes. These articles are read, discussed and filed. Any written material pertaining to the industries is gathered and used for classroom work.

A photographer accompanies the class on all of the trips. The students buy the pictures at cost price and insert them in the proper places in the notebooks. Lantern slides are being made, and a lecture is being prepared to accompany the slides. This will serve as interesting instruction and entertainment in the classroom, the night school and community meetings.

From time to time, the students write articles pertaining to the local industries for the high school paper. Much of the best work in exposition done in the English department has been based upon the study of these industries.

In his seven years as a teacher, the writer has given no course toward which his students, both boys and girls, had an attitude of such interest and appreciation. A number of the class of the previous year, who are graduated and are holding commercial positions, have stated that the work has helped them greatly to be more valuable employes. The magic of the saw reducing logs to lumber, the loading of boats with iron ore and grain, the unloading of coal with four ton clams, the action of a hydraulic press, all are of such compelling interest and educational value, that the most phlegmatic student is drawn out of his lethargy and is instilled with an intelligent pride in his home community.

MODEL "STRUCTURAL STEEL" IN THE LABORATORY.

By H. Lawton Chase, A. M.,
Stevens High School, Claremont, N. H.

The many well-advertised makes of toy structural steel offer an unlimited amount of laboratory material at moderate cost. Where the apportionment for laboratory supplies is not sufficient to enable the installation of the type of apparatus seen at Pratt Institute and the larger high schools, these sets make a most acceptable substitute. Moreover, there are many students taking science who are unable to understand even simple apparatus without thorough manual investigation. To every teacher whose schedule is full comes the demand, oft repeated and certainly worthy of attention, to be allowed to "make something."

A good set of this toy steel fills the gap. When the laws of levers are studied, the development and use of compound levers offers too frequently only mental gymnastics or at least only mathematical drill.

Equip a student with an instruction sheet and let him build for himself a model heavy duty scales, and the computation involved will be seen to amount to something practical when he puts a known weight on the scales he has constructed and sees for himself that his "moments" helped him. Where sets are purchased which have closely spaced holes for bolts, their moments can be secured from the weight times the number of holes distant from the fulcrum, for the average construction experiment. The construction of model bridges, roofs, steel framed buildings and the like, with the methods of tying for rigidity becomes interesting problems when the student can fit the parts together and feel and see the purpose of each. Gears, especially the more interesting combinations, secured for purposes of speed and power as in automobiles offer numerous fascinating problems. Where an electric motor is at hand, even though it is a very small one, all sorts of combinations of pulleys, gears and levers may be built up and efficiency tests worked out, or ratios between speed and power.

I do not believe in placing these sets indiscriminately before students. Fundamental laws should be first understood and then the sets used to study their applications. Nor will it be possible to secure the best results unless the experiments are guided by instruction sheets which force attention to the important facts under consideration.

CALCULATION OF THE SIMPLEST CHEMICAL FORMULA FROM THE PERCENTAGE COMPOSITION.

By O. L. Brauer,
Selma, California.

In these times when the student is confronted with such a multiplicity of facts and phenomena, it is a very serious pedagogical mistake to give a process empirically, when its explanation could be understood by the student. Nevertheless, in some dozen or more textbooks I have looked through, I do not recall a single instance where an explanation was given of the method of calculating the simplest chemical formula from the percentages of composition and the atomic weights. The student-mind craves for an explanation of these things. Those students, who do any thinking, always have a feeling of dissatisfaction when their minds have not found a reason for a process. In this particular instance, it seems to me, a simple explanation could easily be given.

Let P represent the percentage of any element in a compound, A, its atomic weight, N, the number of its atoms in the molecule and M, the simplest molecular weight of the compound.

Then $P = \frac{N \times A \times 100}{M}$ by definition; e. g., the percentage of oxygen in H_2SO_4, $P = \frac{100 \times 4 \times O}{H_2SO_4}$ or $P_h = \frac{100 \times 2 \times H}{H_2SO_4}$. When the per cent sign is dropped, the left side of the equation is really multiplied by 100 so we must multiply the right-hand side by 100, hence the 100 in the right-hand side. Dividing through by A gives the equation in a workable form.

$$\frac{P}{A} = N \times \frac{100}{M}.$$

P, the percentage, is known; A, the atomic weight, is known, so it is possible to calculate $N \times \frac{100}{M}$ for each element in the compound. Since M is the same for each product, $\frac{100}{M}$ is really the highest common divisor of all the values for $N \times \frac{100}{M}$, we get when we use the above equation for each element in the compound.

To calculate the formula from the percentages and atomic weights of the elements in a compound, it is necessary to:

1. Divide each percentage by the atomic weight.
2. Get the highest common divisor, and divide through by

it. The values left are the number of atoms of each element in the molecule.

Sulphuric acid analyzes for 2.04 per cent hydrogen, 32.65 per cent sulphur, and 65.31 per cent oxygen.

H. $2.04 \div 1 = 2.04$.
S. $32.65 \div 32 = 1.02$.
O. $65.31 \div 16 = 4.08$.

	H.	S.	
1.02	2.04	1.02	4.08
	2	1	4

Hence the simplest formula is $H_2 SO_4$. As a rule, the highest common divisor can be found by inspection. Let us take a harder problem.

Potassium ferrocyanide analyzes for 42.38 per cent K, 15.21 per cent Fe, 19.57 per cent C and 22.82 per cent N. Dividing each per cent by the atomic weight we get:

K	Fe	C	N
1.08	.27	1.63	1.63

Getting the greatest common divisor:

3	1.08	.27	1.63	1.63
.09	.36	.09	.54	.54
	4	1	6	6

Hence the simplest formula is K_4 Fe C_6 N_6. The student should be able to calculate the simplest formula for any compound by this method, when the percentages are given.

EDITORIAL COMMENT ON THE ABOVE PAPER.

The author of the above paper mentions the fact that few if any elementary chemistry texts give any explanation of the derivation of formulas from percentage composition. Perhaps the absence of such work from these texts is commendable rather than otherwise as most texts undertake the consideration of more topics than can be well handled in the time available in most schools. The chemistry editor would like to suggest that a very proper way in which to treat this and similar topics is to have volunteer classes after school for ambitious pupils, in which some of the more difficult subjects are taken up and presented much as the paper in question handles the subject of the calculation of formulas from percentage composition. We would also suggest that for pupils who have not had physics or who are less mature than seniors, an even simpler mode of treatment than that of the above paper will probably prove more successful. For example, instead of employing a mathematical expression of the

facts, suppose we simply discuss them in as nearly everyday language as possible. In the case in point, one might say, "If we knew the actual weights in grams of each of the kinds of atoms in this compound and also the actual weights in grams of each of the elements present, we could divide the weight of each element by the weight of its atom and thus find the exact number of atoms present in the given quantity of the compound. After doing this for each element present, we could then relate the numbers of each kind of atom to each other and put them in their lowest terms and thus get the simplest formula for the compound. But we do not accurately know the weight in grams of the individual atoms. Hence we cannot find the actual number present. We do, however, know the relative weights of the atoms. If, now, we should divide the weight of each element present by the relative weight number of its atom, we would not get as our quotient the actual number of atoms present, but if we thus treat each of the elements we will get numbers for quotients which will bear the same numerical relation to each other that the true numbers of atoms bear.

"To show that this method of treatment is correct, let us consider the case of a coffee merchant who buys $400 worth of Mocha coffee and $250 worth of Java coffee and blends them. Now, if we knew the price per pound paid by him for each kind of coffee, we could speedily tell how many pounds of each kind he put into the blend but in the absence of a knowledge of the price per pound, suppose it is known that the prices paid bear the relation to each other of 8 to 5, the Mocha coffee being the higher priced. While we cannot yet tell just how many pounds of each the merchant employed, we *can* find how many of each he used, relative to the other, as follows: If we divide $400 (the amount belonging to the Mocha coffee) by 8 (the relative value of Mocha coffee) we get 50 as our quotient. If we next divide $250 (the amount belonging to the Java coffee) by 5 (the relative value of Java coffee) we get 50 as a quotient. The weights of Mocha and Java coffee used must then have been to each other as 50 is to 50 which in lowest terms is as 1 is to 1.

"Having seen while dealing with common things that the method suggested above is correct, let us apply it to find the simplest formula of, say, sulphuric acid. This substance has been analyzed and is found to contain hydrogen, sulphur and oxygen. If 100 grams are taken we find in it 2 grams of hydrogen, 32.7 grams of sulphur and 65.3 grams of oxygen. Now the

relative weights of the atoms of these three elements are as 1 is to 32 is to 16 approximately. If then, following our practice with the coffee, we divide the amount belonging to each element by the relative number belonging to each element, we will have as quotients numbers which, while not the true numbers of atoms present, will, nevertheless, be in the same numerical relation as the true numbers of the atoms and they may therefore be put in their lowest terms and used to indicate the formula of this substance.

"Example.

"2g/ 1 gives 2.

"32.7g/ 32 gives 1 (nearly).

"65.3g/16 gives 4 (nearly).

"Hence the numbers of hydrogen, sulphur and oxygen atoms present are to each other as 2 is to 1 is to 4. As these numbers are already in lowest terms we may say that in sulphuric acid for every sulphur atom there are two hydrogen atoms and four oxygen atoms or H_2 SO_4."

Other topics that may thus be profitably treated with volunteer classes at the proper times may be suggested—for example:

1. The atomic theory, what it sought to account for and how it does so.

2. Avogadro's Hypothesis, why he brought it out, how it serves to explain Gay Lussac's Law (also Boyle's and Charles' Laws), the necessary consequences of Avogadro's Hypothesis.

3. Molal volume and its use in finding molecular weights of gaseous substances (an application of Avogadro's Hypothesis).

4. Use of osmotic pressures in finding molecular weights (an application of Avogadro's Hypothesis to the case of dissolved substances).

As other means of finding molecular weights:

5. Elevation of boiling point.

6. Depression of freezing point.

7. Law of Du Long and Petit and related laws.

The annual statement on the production of abrasive materials in the United States in 1914 is now available for distribution by the Geological Survey. Under this heading are considered only those mineral products which are used for grinding and polishing and other abrasive operations. The value of all the abrasive materials consumed in the United States during the year amounted to $3,614,263.

A POPULAR ESTIMATE OF THE IMPORTANCE OF BIOLOGY.[1]

By W. L. Eikenberry,
University High School, University of Chicago.

The question of what biology to teach is always with us, and the re-examination of the pedagogical foundations of our present course of study has made the question more acute than usual. So long as the schools appealed to but a single class of the population, the matter was comparatively simple, but the democratization of the high schools has brought about a situation such that our pupils are not being trained primarily for entrance into college. Very much the larger majority will never see the inside of a higher institution. The question of what type of biology we shall teach is therefore conditioned, not simply upon factors internal to the sciences concerned, but also upon the probable future occupations of the pupils and their stations in life.

Doubtless most of us would be fairly well agreed as to the type of training which should be given to the young person who intends to enter biological research, and the colleges have in the past been fairly definite as to the sort of training which they expect of those who enter their doors, whether for research, for professional training, or for general education. No such agency has given us an equally authoritative interpretation of the character of material and type of instruction which would be most appropriate to the pupil who goes from high school directly into our economic and social organization.

There can be no doubt that the possession of certain biological concepts and certain biological information by the entire citizenship of a community would be of the greatest civic importance. For instance, if each of the citizens of Chicago possessed the knowledge of the germ theory of disease and its sanitary implications that is possessed by the present audience, the sanitary regulations of the city would immediately reach a maximum of effectiveness. Their present relative ineffectiveness is largely due to the absence of any common body of knowledge to which sanitary authorities can appeal in seeking effective co-operation. The present conditions in this city are among the best in the country but the very best that we have been able to secure with the greatest difficulty, here or elsewhere in the nation, is far be-

[1]Read before the Biology Section, Central Association Science and Mathematics Teachers, Harrison High School, Chicago, November 26, 1915.

neath the result that might be secured with ease if biological knowledge were universal. If an important part of the office of schools in a democracy is to implant a common body of knowledge which shall enable the citizens of the democracy to cooperate in public questions, we certainly have here a fruitful field for investigation by students of biological pedagogy.

In addition to the concepts which are useful in public matters, there are many other biological items which are important to the individual in a strictly personal sense, matters which concern his own physical well-being or the conduct of his business or profession. These may or may not be the same as those belonging to the preceding category.

Again, there is need for some biological knowledge on the part of the individual if he is to intelligently discuss public questions with his neighbors or if he is to read the literature of the day appreciatively. It would be convenient if the same body of knowledge were to serve all of these purposes and other purposes which might be suggested, but it is scarcely legitimate to assume that this is true.

Actual objective data upon this subject are not abundant. Most of us have opinions regarding the materials which should enter into a course of instruction intended to fit pupils for the actualities of real life and are ready to express them freely upon occasion. Few of us would be willing to suggest a list of major subjects of which we would assert that these and no others should be eligible for use in such a course with a given group of pupils. A few teachers of biology have indeed been experimenting with classes in this field and have secured results which must command the attention of the rest of us. On the other hand, the writer is not aware that anyone has attempted to study in any quantitative way the demands for biological training which are made upon the citizens of our communities or upon any particular group of them.

In conversation with your Chairman a year ago, it was suggested that at least an opening into the problem might be secured by examining the biological references in current literature. Such a study would at least show something of the number and character of biological topics in which it was believed by the editors that intelligent people are interested and which they are able to understand.

It was proposed to examine a representative group of publications, each one appealing to a somewhat different audience.

The difficulties began to appear immediately. The daily papers, the common reading material of the great mass of the population, have been filled with news of the European war to the exclusion of almost everything else. Practically no biological articles or items have appeared, excepting those upon military surgery and sanitation. The *Review of Reviews* was selected as representing a distinct field, but so few biological references have appeared in it that one would be justified in no conclusion unless founded upon the almost total absence of biology from the pages. It was thought that *Good Housekeeping* might represent in some degree another type of interest. Every number of this magazine contains biological articles, and some of them are written by recognized authorities, but a classification of them for our purposes is scarcely possible since they practically all relate to medicine, surgery, sanitation, and nutritional physiology. A fourth publication which it was designed to investigate was the *Literary Digest*. This periodical appeals in general to the educated class, and in each issue there is a department of "Science and Invention." It supplied all the usable data that were collected. In the "Science and Invention" department of the file of this publication, so far as investigated, there were three hundred and eighty-three scientific articles. One hundred and twenty-six of these may be classified as biological. These articles are grouped as follows:

Botany	4
Industrial botany	6
Agricultural botany	5
Forestry	4
Zoology	10
General biology	3
Human physiology	37
Foods	6
Medicine	15
Surgery	11
Sanitation	22
Eugenics and sex hygiene	3
	126

The striking thing which emerges from these very inadequate data is the preponderate emphasis placed upon those topics which in the schools are most commonly designated as

physiology. The writer does not wish to draw any conclusion from the data presented unless it should be relative to the unwisdom of promising a paper before the data are in hand. It may be suggested that any conclusions which might be drawn from data of this sort, if sufficient data were accumulated to justify inferences, would have to be found upon the presence of topics, not upon their absence. Subjects which are discussed abundantly in the public print are by that means brought into the minds of the people; but topics equally important and equally interesting to the people may long escape this sort of public attention.

COMMISSION URGES GOVERNMENT OWNERSHIP OF 5,600,000 ACRES FOR NATIONAL FORESTS IN THE EAST.

That 5,000,000 acres of nonagricultural land should be secured by the federal government in the southern Appalachians and 600,000 acres in the White Mountain region of New England, to form national forests for the protection of the watersheds of navigable streams in the East, is urged by the National Forest Reservation Commission in its latest report.

The Commission has approved for purchase so far 1,104,529 acres in New Hampshire, Virginia, West Virginia, North and South Carolina, Tennessee and Georgia, in accordance with the Weeks Law, which appropriated $11,000,000 for this work, though only about $8,000,000 will have been spent by July 1st, when the appropriation will expire.

A further appropriation providing for continued purchases until 1920 at the current rate of $2,000,000 a year is recommended by the Commission. Under the terms of the Weeks Law, passed March 1, 1911, $1,000,000 was made available for expenditure prior to July 1st of that year and $2,000,000 annually thereafter for five years. Because of the time required to examine and survey the lands and negotiate with owners, the expenditures in the early years of the work were less than the amounts appropriated.

The lands thus far approved for purchase have been obtained on what are regarded as very reasonable terms. The average price is $5.03 per acre, involving a total expenditure of $5,560,202.21, exclusive of the cost of examination and survey. About one-third of the area is virgin timberland, and, while most of the remainder has been cut over or culled, much valuable timber is standing on it also. In 1914 the purchases approved comprised 391,114 acres at the relatively low price of $4.96 per acre. Areas in which land is to be purchased have been designated also in Alabama, Maine, and Maryland, but no purchases in these states have yet been approved by the Commission.

Many of the tracts which are being acquired, says the report, present attractive scenery and afford delightful places in which to travel or rest. Some of the most attractive spots have been inaccessible, but the roads and trails which are being built by the Forest Service will make it easier to reach them. Persons who desire to occupy permanent camp sites, or places in which to erect resorts, may obtain them on payment of a moderate fee. Other special uses which do not injure the forests

are likewise permitted, and demands for such uses have already been made in considerable volume.

Since the uses of the acquired lands are beginning to take form, says the report, it is becoming clear to the public that the forests are to serve the several regions in a number of important ways. Perhaps their greatest use is in the control of forest fires. Roads, trails, and telephone lines will greatly facilitate the protection from fire not only on the government's land but also on private and state lands adjacent to the national forests. In addition, the range can be more completely utilized, the water resources will be more readily available to the public and the general use of the mountains will be increased.

The Forest Service has already begun making improvements. Ninety-two miles of roadway, 520 miles of trail, and twenty-five miles of telephone line have been constructed. This work can be still further extended as soon as proceeds from timber sales begin to come in, as ten per cent of the forest receipts is specifically set apart by law for road and trail construction. Not only will the localities affected benefit in this way, but it is provided by law also that twenty-five per cent of the forest receipts be paid over to the counties affected for roads and schools.

The virgin timberland which is being acquired contains many trees that are overmature, and the stands partially cut over contain certain kinds of timber which were not utilized at the time of lumbering. These lands, where there is a sale for the timber at fair prices, will be freed of this deteriorating material, as well as of such other mature growth as can be spared from the forest without impairing its protective influence. The policy of administration in these forests will call for numerous small timber contractors living near at hand and working in the timber all or a part of the year. Those who may desire to live on government land will have every opportunity to develop comfortable homes, and use available cleared patches for their gardens and crops. Thus, says the report, the forests will be made permanent, and thriving forest communities will be built up.

The forests will also serve as practical demonstrations of forestry in the production of successive crops of timber. Government ownership and management of these extensive areas in the eastern mountains will further benefit the country by providing encouragement and aid for the mountain people in using the resources of the region to best advantage. The nation is getting, from this acquisition of national forests in the East, the added advantage of a large and important region turned to its natural use and made permanently productive, while the protection of watersheds will, in a large measure, produce immunity from both flood and low water in a vast section of the country.

PERSONAL.

Mr. W. S. C. Russell, who has been actively engaged in science instruction for over twenty years in three of the best high schools in New England, has recently connected himself with the Cambridge Botanical Supply Company of Waverly, Mass. Mr. Russell goes to this company for the purpose of acting in an advisory capacity in their scientific and technical departments. He will bring to this work a wide range of experience which will be particularly used for the purpose of advancing the use of high grade instruments and apparatus in the science laboratories of secondary schools throughout the country.

PROBLEM DEPARTMENT.

By J. O. Hassler,
Englewood High School, Chicago.

Readers of this magazine are invited to propose problems and send solutions of problems in which they are interested. Problems and their solutions will be credited to their authors. Address all communications to J. O. Hassler, 2361 W. 110th Place, Chicago.

Algebra.

446. *Proposed by George Raynor, Seattle, Washington.*

Solve:

$$x(x+y+z)-(y^2+z^2+yz) = a. \quad (1)$$
$$y(x+y+z)-(z^2+x^2+zx) = b. \quad (2)$$
$$z(x+y+z)-(x^2+xy+y^2) = c. \quad (3)$$

I. *Solution by Norman Anning, Chilliwack, B. C.*

Put

$$y+z = p, \quad z+x = q, \quad x+y = r.$$

Then $x = \dfrac{(q+r-p)}{2}$ and the given equations become

$$qr-p^2 = a, \quad (1)$$
$$rp-q^2 = b, \quad (2)$$
$$pq-r^2 = c. \quad (3)$$

$$bc-a^2 = p^3qr-pr^3-pq^3+q^3r^3-q^3r^3+2p^2qr-p^4,$$
$$= p(p+q+r)(pq+qr+rp-p^2-q^2-r^2),$$
$$= p(p+q+r)(a+b+c). \quad (4)$$

Similarly,

$$ca-b^2 = q(p+q+r)(a+b+c), \quad (5)$$
$$ab-c^2 = r(p+q+r)(a+b+c). \quad (6)$$

Adding (4), (5) and (6) and multiplying by $a+b+c$,

$$3abc-a^3-b^3-c^3 = (p+q+r)^2(a+b+c)^2.$$
$$\pm\sqrt{3abc-a^3-b^3-c^3} = (p+q+r)(a+b+c) = k, \text{ say.}$$

From (5)+(6)—(4),

$$a(a+b+c)-(b^2+c^2+bc) = (q+r-p)k,$$
$$= 2xk.$$

$$x = \frac{a(a+b+c)-(b^2+c^2+bc)}{\pm 2\sqrt{3abc-a^3-b^3-c^3}}.$$

$$y = \frac{b(a+b+c)-(a^2+c^2+ac)}{\pm 2\sqrt{3abc-a^3-b^3-c^3}}.$$

$$z = \frac{c(a+b+c)-(a^2+b^2+ab)}{\pm 2\sqrt{3abc-a^3-b^3-c^3}}.$$

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

$$\frac{(1)-(2)}{(1)-(3)} = \frac{x-y}{x-z} = \frac{a-b}{a-c}$$

$$x = \frac{y(a-c)-z(a-b)}{b-c}$$

Substituting (4) in (1) and (3) we get

$$y^2[(a-c)(a+b-2c)-(b-c)^2]-2yz(a-b)(a-c)+z^2[(a-b)(a+c-2b)-(b-c)^2] = a(b-c)^2. \quad (5)$$

$$-y^2[(a-c)(a+b-2c)+(b-c)^2]+yz[(a+b-2c)(b-c)+(a-b)(2a+b-3c)] + z^2[(2b-a-c)(b-c)-(a-b)^2] = c(b-c)^2. \quad (6)$$

Eliminating the absolute terms from (5) and (6) and factoring we have $[y^2(a^2+ab+b^2-ac-bc-c^2)-z(a^2+c^2-b^2-bc-ab+ac)](y-z) = 0$

$\therefore y = z,$

and $y = \dfrac{a^2-bc+(c-b)(a+b+c)}{a^2-bc-(c-b)(a+b+c)}\, z,$ (7)

and $x = \dfrac{a^2-bc-(2a-b-c)(a+b+c)}{a^2-bc-(c-b)(a+b+c)}\, z.$ (8)

Substituting (7) and (8) in (3) we get the values of x, y and z as follows: (The values, which agree with those in solution I, are omitted to save space.—Editor.)

When $y = z$, $x = z$; a condition that is true if $a = b = c = 0$ or if $x = y = z = \infty$.

III. *Solution by Clifford N. Mills, Brookings, South Dakota, and the proposer.*

From (1) and (2) we get

$$xy-z^2 = 1/2\,(a+b), \quad (4)$$
$$yz-x^2 = 1/2\,(b+c), \quad (5)$$
$$xz-y^2 = 1/2\,(a+c). \quad (6)$$

From (4), (5) and (6) we get the following equations:

$$x(x^2+y^2+z^2-3xyz) = 1/4\,[(b+c)^2-(a+c)(a+b)], \quad (7)$$
$$y(x^2+y^2+z^2-3xyz) = 1/4\,[(a+c)^2-(a+b)(b+c)], \quad (8)$$
$$z(x^2+y^2+z^2-3xyz) = 1/4\,[(a+b)^2-(a+c)(b+c)]. \quad (9)$$

From (7), (8) and (9) we get

$$\frac{x}{(b+c)^2-(a+c)(a+b)} = \frac{y}{(a+c)^2-(a+b)(b+c)} = \frac{z}{(a+b)^2-(a+c)(b+c)}$$

By principles of proportion it can be shown that each one of the fractions equals

$$\sqrt{\frac{x^2-yz}{[(b+c)^2-(a+c)(a+b)]^2-[(a+c)^2-(a+b)(b+c)]\,[(a+b)^2-(b+c)(a+c)]}}$$

But $x^2-yz = -1/2\,(b+c)$, hence each fraction equals,

$$\frac{1}{2\sqrt{3abc-a^3-b^3-c^3}}$$

therefore the values of x, y and z are easily determined.

Geometry.

447. *Proposed by Daniel Kreth, Wellman, Iowa.*

Given, in a right triangle, the difference between the base and the perpendicular, and also the difference between the hypotenuse and the base, to construct the triangle geometrically and determine its sides.

I. *Solution by H. H. Seidel, St. Louis, Mo., and Elmer Schuyler, Brooklyn, N. Y.*

Given $m = a-b$, $n = c-a$ and $c^2 = a^2+b^2$, where c is the hypotenuse, a and b the legs of the right triangle.

Then, by solving these equations,

$b = n+\sqrt{2n(m+n)}$, $c = m+2n+\sqrt{2n(m+n)}$, $a = m+n+\sqrt{2n(m+n)}$.

Geometrically, we construct a mean proportional between $2n$ and $m+n$ and then add n, $m+2n$, and $m+n$, respectively.

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

Let $m = a-b$, the difference between the legs, and $n = c-a$, the difference between the hypotenuse and one leg.

Then $m+n = c-b$.

At C on the straight line PQ, construct $CE = \sqrt{2n(m+n)}$ and $\perp$ to PQ.

On straight line CE, take CA = CE+n; on PQ, take CB = CA+m. Triangle ACB is the required triangle.

Proof:

$$\begin{aligned} \overline{CE}^2 &= 2(c-a)(c-b), \\ &= c^2+c^2-2ac-2bc+2ab, \\ &= c^2+a^2+b^2-2ac-2bc+2ab, \\ &= (b+a-c)^2. \\ \therefore\ CE+n &= b+a-c+c-a, \\ \text{or}\quad CA &= b. \\ CB &= CA+m, \\ &= b+a-b = a. \end{aligned}$$

From the proof we get at once,

$$\begin{aligned} b &= n+\sqrt{2n(m+n)}. \\ a &= m+n+\sqrt{2n(m+n)}. \\ c &= m+2n+\sqrt{2n(m+n)}. \end{aligned}$$

448. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Given the sides of a triangle equal to a, b, c, respectively, to find the area of its pedal triangle in terms of these sides.

[All the solutions submitted for this problem were incomplete, inasmuch as the only case considered was that in which the pedal triangle lies within the original triangle. The solutions are varied and express excellent ideas and without exception may be modified to include the case where one angle of the original triangle may be obtuse. I'm sure our problem solvers would prefer to wait until a later issue and read the complete solutions which, I trust, will immediately come in.—EDITOR.]

449. *Proposed by N. P. Pandya, Sojitra, Dt. Petlad, India.*

Construct a triangle, having given the perimeter, the vertical angle, and the ratio of the sides containing that angle.

I. *Solution by Roy C. Andrews, Astoria, Ore., Norman Anning, Chilliwack, B. C., Shungo Furni, Selma, Calif., M. Helen Kelley, Wilmette, Ill. (Using notation by Roy C. Andrews.)*

Given the line MN, the angle A and the ratio $m : n$ to construct a triangle with perimeter MN, one angle equal to A and the sides including A in the ratio $m : n$.

On the sides of A lay off AB = m and AC = n and draw BC; call its length x.

Divide MN into three parts m', n' and x' so that

$$\frac{m}{m'} = \frac{n}{n'} = \frac{x}{x'}.$$

Then m', n' and x' are the sides of the triangle required.

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

Let θ be the given angle, $m : n$ the given ratio and $2s$ the perimeter of the given triangle. If the sides of the triangle are a, b and c, we have

$$\frac{a}{b} = \frac{m}{n},$$

and

$$\begin{aligned} c^2 &= a^2+b^2-2ab\cos\theta, \\ &= \frac{m^2}{n^2}b^2+b^2-2\frac{m}{n}b^2\cos\theta. \\ \frac{c^2n^2}{b^2} &= m^2+n^2-2mn\cos\theta = p^2, \end{aligned}$$

or

$$c = \frac{bp}{u}.$$

Since $a+b+c = 2s.$

$$\frac{m}{n}b+b+\frac{bp}{n} = 2s,$$

$$b = \frac{2sn}{m+n+p}.$$

$$a = \frac{2sm}{m+n+p}.$$

$$c = \frac{2sp}{m+n+p}.$$

From these relations the triangle is easily constructed.

III. *Solution by Aaron Freilich, West Philadelphia High School for Boys.*

Given the perimeter p, the vertical angle a and the ratio $m : n$ of the sides of this angle.

Construct a triangle whose vertical angle is equal to a and the sides containing the angle a equal to m and n respectively. Let this triangle be ABC, where $BA = n$ and $BC = m$.

Lay off $RS = p$. At R with RS as a side, lay off angle $\frac{A}{2}$.

At S with SR as a side, lay off angle $\frac{C}{2}$.

Prolong these lines until they meet at Y.

At Y on YR as a side, construct angle $\frac{A}{2}$ interior to triangle YRS and let X be intersection of side with RS. Similarly on YS, lay off angle $\frac{C}{2}$ with side cutting RS in Z. The triangle XYZ is the required triangle.

Proof:

$\triangle XYZ \sim \triangle ABC$ ($\angle YXZ = \angle A$, $\angle YZX = \angle C$).

$\therefore \angle XYZ = \angle ABC = \angle a$ and $\frac{YZ}{YX} = \frac{BC}{BA} = \frac{m}{n}$.

Also $YX = RX$, $YZ = SZ$.

$\therefore XY+YZ+ZX = p$.

IV. *Solution by R. M. Mathews, Riverside, Calif., and Elmer Schuyler, Brooklyn, N. Y.*

[This is published as an excellent example of brevity, with completeness.—Editor.]

On the sides of the given angle A lay off AB and AC in the given ratio. Then triangle ABC is similar to the required triangle, and the sides A'B' and A'C' of the desired triangle can be found as fourth proportionals to the perimeter of ABC, the given perimeter, and AB and AC, respectively.

Trigonometry.

430. *Proposed by O. N. Horner, Peru, Indiana.*

A crossed belt is carried on two pulleys of the same size. If the belt is 10 feet long and half of it is in contact with the surface of the pulleys, what is the radius of the pulleys?

I. *Solution by W. T. Short, Shawnee, Okla.*

Let θ be the angle made by the radius from point of contact and the line of centers. Let r be a radius.

$BA = \frac{1}{4}$ of $\frac{1}{2}$ of 10 ft. $= 1\frac{1}{4}$ ft.

$\tan\theta = \frac{1\frac{1}{4}}{r}$.

Arc CB $= (\pi - \theta)r$ or $\pi - \theta = \frac{1\frac{1}{4}}{r}$.

$\therefore \tan\theta = \pi - \theta$, or $\tan\theta + \theta = \pi$.

By use of table we find that $\theta = 1.1128 \cdots$ radians or 63° 45′ 32″.

$\tan\theta = 2.9288 \cdots$

$r = .61613 \cdots$ ft.

II. *Solution by Clifford N. Mills, Brookings, South Dakota.*

Since the pulleys are of the same size, $2\frac{1}{2}$ ft. of belt will touch each pulley. If r is the radius of the pulley and θ the angle subtended at the center by the belt in contact, then the length of the belt in contact with each pulley is $r\theta$ feet, where θ is measured in radians, hence

$$r\theta = 2\tfrac{1}{2} \qquad (1)$$

Also $\frac{1}{4}$ the length of the belt is between the crossing and the point of contact. Therefore

$$\tan(180 - \theta/2) = \frac{5}{4r} \qquad (2)$$

From (1) and (2) we get

$$\tan(180 - \theta/2) = +\theta/2 \qquad (3).$$

Plot the curves $y = \tan\theta/2$ and $y = -\theta/2$, we find that the point of intersection gives $\theta = 1.292\,\pi$ radians. Therefore, $r = 5/8$ ft. approximately and the distance between the centers is 2 4/5 ft.

CREDIT FOR SOLUTIONS.

446. Norman Anning, Clifford N. Mills, George Raynor, Nelson L. Roray, one incorrect solution. (5)

447. Shungo Furni, R. M. Mathews, Nelson L. Roray, Elmer Schuyler, H. H. Seidel, W. T. Short. (6)

448. Eight incomplete solutions.

449. Roy C. Andrews, Norman Anning, Aaron Freilich, Shungo Furni, M. Helen Kelley, R. M. Mathews, Nelson L. Roray, Elmer Schuyler. (8).

450. Norman Anning, R. M. Mathews, Clifford N. Mills, Nelson L. Roray, Elmer Schuyler, W. T. Short. (6)

Total number of solutions, 33.

PROBLEMS FOR SOLUTION.

Algebra.

461. *Proposed by Claude O. Pauley, Linden, Ind., and William E. Curtis, Somerset, Mass.*

Solve the equations:

$$x^2 + y = 7 \qquad (1)$$
$$y^2 + x = 11 \qquad (2)$$

462. *Proposed by Harry C. Carver, Shortridge High School, Indianapolis, Ind.*

Eliminate x from the equations:

$$\frac{\cos(a - 3x)}{\cos^3 x} = \frac{\sin(a - 3x)}{\sin^3 x} = b.$$

Geometry.

463. *Proposed by Richard S. Beardsley, Englewood High School, Chicago, and George Raynor, Seattle, Washington.*

The medians of a triangle meet in the point M, the altitudes in the point T, and the perpendicular bisectors of the sides in the point P. Prove that points M, T and P are collinear and that M divides the line segment so that PM : MT :: 1 : 2.

464. *Proposed by N. P. Pandya, Sojitra, Dt. Petlad, India.*

The symmedian point, the nine-points center and the point of concurrence of the joins of the vertices with the points of contact of the incircle on the opposite sides are known. Show how to construct the triangle.

465. *Proposed by Clifford N. Mills, South Dakota State College, Brookings, S. D.*

Given an angle and two points A and B between the sides of the angle. Show how to find the shortest path from A to B that touches both sides of the angle.

Class Room Sayings.

Q.: Why are furs "warm?"
A.: Because they are poor conductors of heat and conduct the cold away.
A. (another boy): The hairs on the furs makes the furs warm.

Q.: What occurred when alcohol was placed between two floating sticks?
A.: The alcohol made them separate fastly.

Define viscosity.
A.: Viscosity is the resistance of a force to change its form without internal affliction.

Give a practical use of the hydraulic press.
A.: The hydraulic pump is used for water jacked. Because it has four valves one for inlet and one for outlet.

Give construction of a radiometer.
A.: In a radiometer most of the air is pumped and the bulb is now full of vacuum.

Q.: At what point on the earth will a dipping needle point vertically?
A.: The needle will point N. and S. at Belfast and where the axis of the earth is.

Define porosity.
A.: Porosity is the property of having holes or mooly coodles.

Define dispersion.
A.: Dispersion is the opening or separating of a bean of light.

Q.: What is done to prevent local action?
A.: Dip the zinc in some mercury. This is called alamagation.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

189. *Proposed by A. Haven Smith, Riverside, Cal.*

What is the numerical value of the heat of vaporization of water at temperatures other than 100°C.?

208. *Proposed by Maxwell Sosin, Perth Amboy, N. J.*

Sound travels, approximately, 1 mile in 5 seconds. Suppose a man on a hydroplane above some vast body of water, traveling at that rate, fired a gun. Since he is moving with the same velocity as the report of the gun, it seems that he would not cease to hear the sound.

209. *Proposed by W. L. Baughman, East Saint Louis, Ill.*

How much should the outer rail of a 5-foot track be raised above the level of the inner rail in order that a train may safely run a curve of one-eighth mile radius at the rate of 30 miles an hour?

Please answer questions numbered 210, 211 and 212 in the succeeding list.

Princeton Physics, June, 1915.

210. A rifle bullet leaves the muzzle of the rifle with a velocity of 750 meters per sec. The barrel is 80 cm. long. Assuming the acceleration to be constant, find its value in cm. per sec. per sec. Also find the time taken to traverse the barrel.

211. A piece of platinum weighs 71.2 grams when submerged in mercury—what is the volume of the platinum? What would it weigh if it were submerged in alcohol?

Sp. Gr. of platinum = 21.5, of mercury = 13.6 and of alcohol =0.8.

3. Express 79°F. in C.; —40°F. in C.; and 1700°C. in F.

80 grams of steam at 100°C. are turned into 536 grams of ice at 0°C. What will the resulting temperature be?

Heat Eq. of Fusion = 80. Heat Eq. of Vaporization = 536.

212. A hot-air balloon, when inflated with air at 40°C. above the temperature of the surrounding air, displaces 1 cubic meter. The density of air at the ordinary temperature is 0.0012 grams per cu. cm., and the coefficient of expansion = 0.0037. Calculate the total lifting power due to the heated air.

5. Make diagrams of the light rays in an ordinary camera and in an ordinary field glass.

A light is placed 8 ft. from a concave spherical mirror and the image of the light is 16 ft. from the mirror. Find the principal focal length and the radius of curvature of the mirror.

6. Three + electric charges, 10, 20 and 40 units respectively, are placed at three points in a straight line, with 10 cm. between the 10 and 20, and 20 cm. between the 20 and 40. Calculate the size and direction of the resulting force on the charge 20

How much heat, in calories, will be produced in 24 hours by a current of 10 amperes flowing through a resistance of 10 ohms?

Solutions and Answers.

189. *Also answered by A. H. Smith, Riverside, Cal.*

193. *Also solved by A. G. Montgomery, Athens, W. Va.*

194. *From an entrance examination of Columbia University.*

A man weighing 150 pounds carries a load of 70 pounds up an incline of one in ten. If he walks at the rate of one thousand feet per minute, what horsepower is he exerting? Answer to be in foot pounds per second.

[Is the answer reasonable? Should problems with unreasonable answers be given, especially on examinations?—EDITOR.]

A solution by A. Haven Smith that was received too late for publication in the January issue.

$150+70 = 220$ pounds, total load raised

$220\times10 = 2200$ foot pounds, work done per 100′

$2200\times10 = 22000$ foot pounds, work done per minute

$22000\div33000 = \frac{2}{3}$ H. P.

This answer is reasonable, provided the man is not required to keep up this pace for any considerable length of time. Our school is on the edge of an arroyo some 45 feet deep. There are steps leading from the school into the arroyo. Each year while studying horsepower we run up these steps to see who can develope the most horsepower. It takes from 7 to 10 seconds for the boys to cover the distance, and the highest horsepower developed is 1.6, the lowest 1.0.

I do not believe in giving unreasonable problems in examinations.

195, 196. *Also solved by A. H. Smith.*

197. *From a Yale College entrance examination paper.*

Assume that a sample of sulphuric acid has the specific gravity of 1.8 and contains 98 per cent H_2SO_4. How many grams of the compound H_2SO_4 are contained in 25 c. c.?

Solution by Roy E. Jensen, Belle Vernon, Pa.

Also solved by R. W. Boreman, Parkersburg, W. Va.

25 c. cm. of water weighs 25 grams. If specific gravity of sample is 1.8, 25 c. cm would weigh 1.8×25 grams $= 45$ grams. 98% of 45 grams $=$ 44.1 grams of H_2SO_4.

199. *Proposed by S. Ralph Powers, Terre Haute, Ind.*

The following equations have always been more or less troublesome to me from the standpoint of presentation and I would be glad to have an expression of opinion concerning them through SCHOOL SCIENCE AND MATHEMATICS:

$$3Cu+8HNO_3 \rightarrow 3Cu(NO_3)_2+2NO+4H_2O.$$

$$Cu+2H_2SO_4 \rightarrow CuSO_4+SO_2+2H_2O.$$

From Mr. Powers' letter in which the above question was proposed:

As ordinarily explained the copper is assumed to attack the nitric acid, liberating hydrogen, which is at once oxidized to water with the production of nitric oxide. This it seems to me is incorrect, for we know that copper does not displace hydrogen from acids. It seems to me better to consider copper as acting directly as a reducing agent and, instead of developing the equation as in A, develop it as in B.

(A) $3(Cu+2HNO_3 \rightarrow Cu(NO_3)_2+H_2)$

$2HNO_3 \rightarrow H_2O+2NO+3O$

$3H_2+3O \rightarrow 3H_2O$

(B) $2HNO_3 \rightarrow H_2O+2NO+3O$

$3Cu+3O \rightarrow 3CuO.$

$3CuO+6HNO_3 \rightarrow 3Cu(NO_3)_2+3H_2O.$

It is characteristic of acids to act with metallic oxides to produce salts and water.

For a representation of the action of sulphuric acid on copper I would for the same reason prefer (B) to (A).

(A) $Cu+H_2SO_4 \rightarrow CuSO_4+H_2$
$H_2SO_4 \rightarrow H_2O+SO_2+O$
$H_2+O \rightarrow H_2O,$

(B) $H_2SO_4 \rightarrow H_2O+SO_2+O,$
$Cu+O \rightarrow CuO,$
$CuO+H_2SO_4 \rightarrow CuSO_4+H_2O,$

It seems to me that the point involved here is of considerable pedagogical importance.

Note by the Editor.

The method of explanation represented by equations *A* and *B* above seems unfortunately to be adhered to by many of our textbook writers. I have never seen a statement of the experimental evidence on which such an explanation is based. On the contrary the evidence which the elementary student *sees* is all in favor of method B. For instance, if nitric acid (sp. gr. 1.4) is put on bright copper, the latter at once darkens, showing the formation of black copper oxide while brown fumes are given off. As the concentration of the nitric acid drops and the amount of water increases (as a result of the chemical action), the characteristic greenish color of copper nitrate appears.

In the copper-sulphuric acid reaction, black copper oxide also appears. It would thus seem that the nascent hydrogen is brought in as a *device* for explanation rather than because it is in accord with experimental facts.

Answer by P. M. Glasoe, Ph. D., St. Olaf College, Northfield, Minn.

The reactions mentioned are simple enough when one understands how they are built up. When nitric acid acts on copper we never get free hydrogen, but nitric oxide is given off. The first step may be indicated thus: $Cu+2HNO3 = Cu(NO3)_2+H_2$ (a)

but the nascent hydrogen instantly attacks the nitric acid, reducing it to water and nitric oxide:

$3H_2+2HNO3 = 4H_2O+2NO.$ (b)

In order to add these two reactions we must multiply equation (a) by three so as to get enough hydrogen to give the second equation:

$3Cu+6HNO3 = 3Cu(NO3)_2+3H_2$
$3H2+2HNO3 = 4H2O+2NO$
$3Cu+8HNO3 = 3Cu(NO3)_2+4H_2O+2NO$

The same explanation suffices for the next reaction. Heat must be applied to start the action:

$Cu+H_2SO_4 = CuSO_4+H_2$
$H_2+H_2SO_4 = 2H_2O+SO_2$
$Cu+2H_2SO_4 = CuSO_4+2H_2O+SO_2$

An allied problem proposed and solved by Claude Schuder, Sumner, Ill.

When copper and dilute nitric acid are mixed the products are water, nitrate oxide, and copper nitrate.

Find by algebra, the proportions of copper and nitric acid used.

My solution of above: x = parts of copper, y = parts of acid.
$xCu+yHNO = xCu(NO_3)_2+y/2\ (H_2O)+(y-2x)NO$

Multiplying by two and performing indicated operations, $2xCu+2yH+2yN+6yO = 2xCu+4xN+12xO+2yH+yO+2yN+2yO-4xN-4xO$
Combining like terms, $3yO = 8xO$, $3y = 8x$, or $x:y::3:8$
Substituting smallest integers having this ratio,

$3Cu+8HNO_3 = 3Cu(NO_3)_2+4H_2O+2NO.$

ANNUAL MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, CHICAGO, ILL.

GENERAL MINUTES.

The fifteenth annual meeting of the Central Association of Science and Mathematics Teachers was held in the Carter H. Harrison Technical High School. This fine, large, new building offered excellent accommodation for the meeting, and the Committee on Local Arrangements anticipated every need.

The General Sessions were held in the Auditorium of the building and were presided over by President Spicer. At the Friday morning session the Association was hospitably welcomed by Principal F. L. Morse of the Harrison High School, Chicago. Miss Emma Conley, State Inspector of Domestic Economy, Madison, Wis., replied on behalf of the Association. The principal addresses of the morning session were given by E. R. Hedrick, Department of Mathematics, University of Missouri; Cyril G. Hopkins, Professor of Agronomy and Chemistry, University of Illinois, and Edward A. Steiner, Professor of Sociology, Grinnell, Iowa. Dr. Hedrick's subject was "Required Mathematics in Secondary Schools and by Colleges," Dr. Hopkins spoke on "The Application of Science to Soil Fertility," and Dr. Steiner brought "A Message from the Sociologist to Teachers of Science and Mathematics." At the close of the morning session, the President announced the following committees:

Nominating Committee—Willis E. Tower, James F. Millis and Charles H. Smith.

Auditing Committee—Fred R. Nickles, L. C. Irvin and Charles H. Perrine.

Friday afternoon was occupied with section meetings, and an informal reception in the foyer of the building. At 6 p. m. nearly two hundred members gathered in the commodious dining hall for the annual dinner. At 7:45 p. m. the Association assembled in the Auditorium, where they were addressed by William B. Itner, Architect, Board of Education, St. Louis, Mo., and William R. Moss, Chicago Association of Commerce on "Relation of Business to the Physical Phase of the High School." Professor A. A. Upham, head of the Physics Department, Normal School, Whitewater, Wis., was unable to appear on the program as scheduled on account of illness. The Secretary was ordered to express the sympathy of the Association to Professor Upham, and also to Miss Marie Gugle, who was absent because of illness.

During the morning and evening sessions, the Association was favored with musical numbers rendered by the Choral Society, Glee Clubs, and individuals of the Carter H. Harrison School, which contributed in no small measure to the success of these meetings. The appreciation of the Association is expressed in resolutions which are given later.

The Saturday morning session was devoted to business. The minutes of the last general meeting were read and approved.

The Committee on Four Year High School Science Course gave a detailed and comprehensive report of its work through its Chairman, Dean Otis W. Caldwell. The report including its recommendations was adopted and the committee continued. The report will appear in the *Proceedings* of the Association. It was ordered that the committee be reimbursed to the amount of forty-one dollars for expenses incurred in this work.

James H. Smith, Chairman of the Committee on Resolutions, presented the following resolutions which were read and adopted:

The Committee on Resolutions recommends the adoption of the following:

RESOLVED, That the Association expresses its thanks to the Board of Education of the city of Chicago for the use of this magnificent building, and to Principal Frank L. Morse, his teachers and pupils, who by thoughtful care for the comfort of our members, and by well-rendered music have greatly enhanced the value of the meeting.

RESOLVED, That the Association records its deep obligation for the flourishing condition of the Association and for the great value of this meeting to the President, Mr. C. E. Spicer, who has wisely guided the affairs of the Association; to the Treasurer, Mr. H. R. Smith, who has carefully managed the finances; to the Secretary, Mr. A. W. Cavanaugh, whose constructive work has aided in many ways; to the Membership Committee, Mr. A. W. Allison, Chairman, whose aggressive campaign has produced gratifying results; to the Publicity Committee, Messrs. H. E. Cobb and Louis E. Pope, who have favorably kept the work of the Association before the public; and to all others who have worked for the promotion of the Association.

Whereas, The reorganization of elementary and secondary schools has been under discussion by educators for several years,

Whereas, The actual reorganization is now going on in some schools and seems about to occur in many schools,

Whereas, The difficult problems of reorganization call for the experience and wisdom of both administrators and teachers,

Whereas, The Association at its thirteenth meeting voted in favor of "Reducing the time of the elementary schools from eight to six years, and increasing the period of secondary schooling from four to six years," therefore,

RESOLVED, That the Association recommends for the main topic of the next meeting, "Science and Mathematics in the High School of Tomorrow."

RESOLVED, That the Association recommends that the whole or a part of one general session be devoted to the subject, chiefly from the administrative point of view; that administrators be invited to be present at the meeting and take part in it; and that the program be arranged so as to provide for the discussion of the topic.

RESOLVED, That the whole or a part of at least one of the meetings of each section be devoted to the subject chiefly from the point of view of the teacher.

RESOLVED, That the adoption of these resolutions is to be construed as a recommendation to the Executive Committee and not binding upon it.

Respectfully submitted,

JAMES H. SMITH,
H. L. TERRY,
Committee.

The report of the Committee on Necrology was read by the Secretary. It was ordered adopted and entered in the minutes. The report follows:

Members of the Association deceased during the past year:

C. F. Adams, Central High School, Detroit, Mich. Mr. Adams was a member of the Physics Section. He joined the Association in 1906.

Miss Cora Hathorn, High School, Mason City, Iowa. Miss Hathorn joined the Association in 1913.

Miss Martha Nye, Rockford College, Rockford, Ill. Miss Nye was a member of the Mathematics Section. She joined the Association in 1910.

The report of the Committee on Publicity consisted of two parts. Its Chairman, Herbert E. Cobb, reported the work being done in disseminating information concerning the C. A. of S. and M. T. Louis E. Pope presented the second phase of the work, i. e., the acquiring of information

regarding the work of other similar organizations. The report was accepted.

The report of the Committee on the Revision of the Constitution was made by Charles H. Smith. Mr. Smith stated that the proposed changes had been published in the October number of SCHOOL SCIENCE AND MATHEMATICS, thus complying with the requirements of the Constitution. The changes were adopted, and are as follows:

Article 4, first sentence: This Association shall be divided into sections as follows: Agriculture, Biology, Chemistry, Earth Science, Home Economics, Mathematics and Astronomy, and Physics.

Article 6, Section 1: The officers of the Association shall be a President, a Vice-President, a Recording Secretary, a Corresponding Secretary, a Treasurer, and an Assistant Treasurer.

Article 6, Section 4, sentences 3 and 4: The President, Vice-President, Corresponding Secretary, and Assistant Treasurer each shall be elected for a term of one year. The Recording Secretary shall be elected for a term of two years.

The Chairman of the Auditing Committee reported the Treasurer's accounts in a satisfactory condition. The Treasurer's report followed and both reports were adopted.

The Nominating Committee reported the following:

President—Herbert R. Smith, Chicago.

Vice-President—Edith Long, Lincoln, Neb.

Corresponding Secretary—Charles W. Newhall, Faribault, Minn.

Treasurer—John H. McClelland, Chicago.

Assistant Treasurer—H. C. Krenerick, Milwaukee, Wis.

The Secretary was ordered to cast the ballot of the meeting for the persons nominated, and they were duly elected.

It was ordered that a committee of fifteen be appointed to draw up resolutions protesting against the notorious inaccuracy of railroad and steamship maps in the United States, and that this committee do all in its power to bring about the correction of these maps.

Invitations from several cities for the 1916 meeting were received. The selection of place of meeting was left to the Executive Committee.

Mr. Burns, Chairman of the Excursion Committee, reported the time and place of assembling of the various excursions.

A. W. CAVANAUGH,
Secretary.

REPORT OF LOUIS E. POPE, OF PUBLICITY COMMITTEE.

In May, 1915, a letter was sent to twenty-one Associations of Science and Mathematics Teachers seeking information as to their activities. They were asked as to membership requirements, publications, what committees are at work, upon what line of work they were placing particular importance and methods used for increasing interest in the organization and for enlarging its membership.

Out of the twenty-one there were ten answers.

From these answers it appeared that interest in the work or being engaged in teaching mathematics or science constitute the ordinary requirements for membership.

Some of the committees at work are as follows: Present Status of High School Mathematics; Pre-High School Mathematics; New Books; New Apparatus and Appliances; Current Events in Physics; Current Literature; Mathematics Courses for Junior High Schools; Mathematics Courses for Senior High Schools.

A few of the Associations have no standing committees, but appoint special committees from time to time.

For the most part, the methods employed in enlarging the membership consist in making the programs vital and interesting, and in sending blank applications to members to be handed on to their friends and colleagues.

Reports of Associations on publications were as follows:

Michigan Schoolmasters' Club—Annual report.

Iowa Association of Mathematics Teachers—No regular publications.

Illinois State Teachers' Association—Annually publish *Proceedings* and issue *The Illinois Teacher* monthly.

The Physics Club of New York—No regular publications, but "occasional 'boiled down' reports of excursions to manufacturing plants, lists of members," constitution and "brief history."

National Society for the Study of Education, Urbana, Ill.—Two year books.

New York State Teachers' Association—Programs of meetings.

Kansas Association of Mathematics Teachers—*Annual Register.*

Eastern Association of Physics Teachers—Full reports of each of the three meetings of the year.

Association of Mathematics Teachers in New England—Publish reports of committees.

Association of Ohio Teachers—Programs of annual meetings.

To bring the different associations into closer relationship and to enable each to get the benefit of all, might it not be a good thing to endeavor to establish a visiting membership whereby some member of each organization should represent his Association at each meeting of certain of the other Associations?

MINUTES OF AGRICULTURAL SECTION.

The Agricultural Section convened in Room 118 of the Carter Harrison High School Friday afternoon, November 27th—Prof. A. W. Nolan presiding. Secretary Ivins was not present and Mr. E. B. Collett of DeKalb, Ill., was appointed. Nominating Committee was appointed as follows: Mr. L. V. Starkey, Platteville, Wis.; Mr. Alfred Tate, Rollo, Ill.; Mr. E. B. Collett, DeKalb, Ill.

The following papers were read :

"Fitting Agriculture into the High School Curriculum"—Alfred Tate, Principal, Rollo, Ill., Consolidated School.

"Making the Department of Agriculture Serve Both School and Community"—L. A. McKeane, Township High School, Toulon, Ill.

Saturday Morning Session.

Chairman A. W. Nolan was unable to remain and appointed L. V. Starkey of the Platteville, Wisconsin, Normal School to preside. The Nominating Committee reported as follows:

Chairman—Prof. N. A. Goddard, Minneapolis, Minn.
Vice-Chairman—L. A. McKeane, Toulon.
Secretary—H. S. Bauer, Chicago.

The report was accepted and the nominees elected.

Superintendent E. J. Tobin of Cook County gave an address on the "Value of Rural Life Directors in the Rural School System."

"The Public Schools' Responsibility for a System of Permanent Agriculture"—Chas. H. Keltner of DeKalb, Ill., Normal School.

"Some Phases of Animal Husbandry Teaching in Secondary Schools"—Prof. W. H. Smith, University of Illinois.

E. B. COLLETT,
Secretary.

MINUTES OF BIOLOGY SECTION.

The Biology Section of the Central Association of Science and Mathematics met at 1:30 p. m., November 26th, in Room 302 of the Harrison Technical High School, Chicago. Mr. Fred T. Ullrich, Platteville Normal School, Wis., presided. Seventy people attended this meeting.

The Chairman appointed as Nominating Committee the following persons: Dr. Elliot R. Downing, William T. Pierson and Chas. W. Finley.

The first paper was "A Popular Estimate of the Importance of Biology," by W. L. Eikenberry, of The School of Education, University of Chicago. As Mr. Eikenberry was unable to attend, the paper was read by the Secretary.

"Preparation for Teaching Biological Subjects" was ably discussed by Otis W. Caldwell, of the School of Education, University of Chicago. This paper brought forth a question from Miss Brown of the Wendell Phillips High School, Chicago, as to whether or not a recitation was best conducted by the question and answer method. Dr. Caldwell called upon Miss Monsch, of the Fröebel School, Gary, Ind., for an answer. Miss Monsch told how a rubber plant she was repotting called forth a question from one of her pupils who was passing, and she showed how this led to the presentation of any number of problems in the study of plant life.

Dr. Caldwell then told of his experience when inspecting a New England school. The teacher was giving a lesson on the Grand Canyon, which no one of the class had seen, and which proved a failure. Out of the window every child could see a wonderful waterfall. This same teacher in the next period presented a lesson in botany, which she said she knew nothing about, in a very simple and successful way.

Mr. Conrad of the Crane Technical High School, Chicago, wondered if the malady of poor teaching had made any perceptable change in the previous years, and if there was a possibility that the malady might cure itself.

Dr. Caldwell replied that as better conditions had been brought about in communities by co-operation of individuals, there was a possibility in increased effectiveness being obtained through the study of conditions in schools by the teachers themselves.

Miss Leavith, High School, Minneapolis, Minn., suggested that it was possible that the teaching of so many sciences needed too great preparation, and that it might be better to teach one science with German or English. This would need less preparation, and she thought that those who taught other subjects than science were more looked up to.

Dr. Downing, School of Education, University of Chicago, showed that in actual practice teachers are not taking up this combination of subjects.

Mr. Ullrich stated that actual investigations in the failures of teachers in agriculture were shown to be due to lack of preparation on the part of the teachers.

Mr. Harold Shinn, of the Carl Schurz High School, Chicago, presented in his paper, "Can the Laboratory be More Efficient?" some interesting methods for efficiency.

In the discussion of this paper, Mr. Sackett, Soldan High School, St. Louis, and Mr. Holtzman, Waller High School, Chicago, emphasized the care on the part of the teacher to make all directions explicit, and showed the necessity for efficiency quizzes.

Mr. Packard of Peoria, Ill., told how real research work could be carried out in investigation of the conditions governing the breeding of flies in a community, also the study of the causes of contagious diseases.

Dr. Downing said this method of teaching made the subject of zo-ology practical. He showed that the rapid increase in election of agriculture showed that practical problems were of more interest to pupils.

Mr. Goddard, State Inspector of High Schools, Madison, Wis., said he thoroughly believed in getting away as far as possible from teaching college work. Pupils should get acquainted with animals in everyday life. Give concrete experiences, get pupils to raise their own problems.

Mr. Whitney, Hyde Park High School, Chicago, said that efficiency was only developed through interest in the subject. Much, of course, depends on the personality of the teacher. Get an atmosphere in the laboratory by having living plants and animals always present.

Dr. Jean Dawson, Normal Training School, Cleveland, Ohio, concluded the morning program with her paper, "Social Biology." This paper was so thoroughly treated that it did not arouse much discussion.

The question was asked Dr. Dawson "whether the fly campaign in Cleveland had noticeably reduced the death rate in Cleveland?" Dr. Dawson stated that the health officers were so much opposed to her work, that they would not allow any statement to be issued.

The Saturday morning session was held at 10 a. m. in Room 305 of the Harrison Technical High School. It was voted to hold the regular business meeting at the end of the session.

In the paper, "Biology in the High School from the Standpoint of Administration," John G. Coulter, Editor of *School Science Series,* Bloomington, Ill., advanced the theory that we cannot decently in one year teach the common elements of science in secondary education (plants, animals, and man), and teach them as they should be taught, on an organized rather than on a disorganized basis. He stated that he has found that the opposition to a two-year plan of science comes mainly from the teachers and not from the administration.

Dr. Dawson of Cleveland, Ohio, asked Mr. Coulter if he could see any reasonable explanation for leaving the study of man until the last part of the course. She wished to know why the science instruction should be first introduced into high school. She pointed out the fact that the child in the grades is at the stage where problems confront him. This is the age when the child must know the why and the wherefore of things. Why not begin this study in the grades? Why kill the inquiring mind at this stage by work which is not fitted for the child?

H. N. Goddard, State Inspector of High Schools, Madison, Wis., followed Mr. Coulter in the discussion of "Biology in the High School from the Standpoint of Administration." Mr. Goddard traced the evolution of science teaching, and said that the introduction of general science was based on good pedagogy. He pointed out that specialists had made boundary lines in science which do not exist for the child. Why shall we persist in holding on to these boundary lines? The biggest thing is to get an honest view of the child's surroundings.

Time was lacking for the discussion of these ideas of Mr. Goddard's.

Mr. Ewers of the Cleveland High School, St. Louis, read an interesting and instructive paper on the care of a greenhouse in connection with high school work.

Miss Nettie M. Cook, Springfield High School, called on the various people who brought exhibits to explain somewhat the setting of the material shown, and a very brief discussion followed.

The Nominating Committee gave their report, but Mr. Harold Shinn

moved that a unanimous vote be cast to retain the officers of the past year. This vote was taken. The meeting adjourned to take a trip with Dr. Henry C. Cowles, University of Chicago, to the conservatory at Garfield Park.

NETTIE M. COOK,
Secretary.

REPORT OF CHEMISTRY SECTION.

Saturday, 10 a. m.

The section was called to order by Chairman L. B. Altaffer.

The Committee on Nominations reported as follows:

Chairman—S. G. Engle, Gary, Ind.
Vice-Chairman—Chas. J. Pieper, Minneapolis, Minn.
Secretary—Frances Church, East High School, Des Moines, Iowa.

On motion of F. T. Jones, the Secretary was instructed to cast the ballot for the nominees as officers for the ensuing year.

There was a joint meeting of the Chemistry and the Home Economics Sections held on Friday, November 26th, an account of which will be found in the minutes of the Home Economics Section. The program for Saturday, November 27th, was as follows:

I. Paper, "The Students' Side of the Subject"—H. R. Radcliffe, Connersville, Ind.
II. "A Survey of the Methods Used in Teaching Laboratory Chemistry in High Schools":
    1. "Conditions as They Should Be."
        (*a*) Sections C, E, F, G and 76—Alexander Smith, Head of Chemical Department, Columbia University, New York.
        (*b*) Sections A, B, D, 75 and 77—Franklin T. Jones, University School, Cleveland, Ohio.
    2. "Conditions as They Are"—S. Ralph Powers, Director of the Survey, Garfield High School, Terre Haute, Ind.
    3. Open Discussion.
III. Reports on Plans of Work for the Coming Year.
    1. "Fundamental Experiments for Every Pupil Studying Chemistry"—H. A. Mess, Nicholas Senn High School, Chicago.
    2. "Lines of Work Suitable for Chemical Study by Practical Experiments"—H. R. Smith, Lake View High School, Chicago.
    3. "A New Chemical Education"—Franklin T. Jones, University School, Cleveland, Ohio.

By unanimous vote the section expressed its thanks and appreciation for the excellent report on the chemical survey made by Mr. S. R. Powers.

The following committee was appointed by the Chairman to confer with a committee from the Home Economics Section:

F. M. Emory, Harrison Technical High School.
A. L. Smith, Englewood High School.
H. C. Wright, University High School.

Miss Frances Church reported the following resolutions, which were unanimously adopted:

Your Committee on Resolutions hereby submits the following:

RESOLVED:

1st.—That we recognize the fruitfulness of the joint session with the Home Economics Section and that we co-operate with the committees appointed in their efforts to determine what ground there is for correlated work.

2nd.—That we heartily commend the growing tendency toward continuity of work in the Chemistry Section which continuity has been made possible by the work of the various committees and that more be made of this feature until the work of the section extends through the entire year rather than a few weeks prior to the meeting.

3rd.—That we acknowledge our appreciation of the careful and extensive work done by Mr. S. Ralph Powers in securing and arranging data for the Chemical Survey.

4th.—That we thank the officers of the section for the excellent program arranged, every subject of which is teeming with vital interest; and, lastly, to those who have so generously consented to take part in this program, we wish to express our grateful appreciation of their helpfulness.

Respectfully submitted, FRED D. GROBE,
RALPH ROBERTS,
FRANCES CHURCH,
Committee.

Adjourned.

F. E. GOODELL,
Secretary Pro Tem.

MINUTES OF HOME ECONOMICS SECTION.

Joint Chemistry and Home Economics Section,

Friday, November 26, 1915.

Meeting was called to order at 2:20 by Miss Agnes K. Hanna, Chairman.

Paper, "At What Point in the Home Economics Course Should Chemistry be Made an Organic Part?"—Abby T. Marlatt, University of Wisconsin.

The discussion was led by Mr. G. C. Ashman. The relation of chemistry and food study when these two subjects are given during the same year was considered.

Paper, "The Specific Contributions of General Chemistry to Home Economics"—Nellie E. Goldthwaite, New Hampshire College.

Miss Goldthwaite was unable to attend the meeting and her paper was read by Miss Katherine Blunt of the University of Chicago. Miss Blunt asked for a consideration of the value of the household chemistry course, consisting of one-half unit of general chemistry and one-half unit of organic and food chemistry.

Paper, "Some Results Secured by a Close Relation between Chemistry and Home Economics Courses"—Carlotta C. Greer, East Technical High School, Cleveland.

There were a number of questions raised as to the advantages and disadvantages of presenting science work in food classes rather than as prerequisite material, also as to the definition of an applied science. The discussion was led by Mr. W. F. Roecker.

Paper, "A Study of the Relative Contributions of Chemistry and General Science to Home Economics"—Grace G. Hood, Lewis Institute.

The point was brought out that physics and the biological sciences contribute a larger share than chemistry to beginning work in foods, whereas chemistry was essential to an understanding of nutrition which is a later problem.

On motion of Mr. S. C. Engle it was voted that the work of the joint meeting of the Home Economics and Chemistry Sections should be continued by a committee from these sections to be appointed by the Chairman. This committee is to report in both sections at the 1916 meeting.

The meeting was adjourned at 5 p. m.

Saturday, November 27, 1915.

Meeting was called to order at 10:25 a. m. by Miss Agnes Hanna, Chairman.

Paper, "The Organization and Place of Marketing in the High School"—Alice Loomis, University of Nebraska.

Paper, "The Relation of Household Decoration and Household Management"—Ethelwyn Miller and Mabel Ward, University of Chicago.

Business meeting was then called. The Nominating Committee reported the following names for consideration:

Chairman—Miss Edna White, University of Ohio.
Vice-Chairman—Miss Carlotta Greer, Cleveland Technical High School.
Secretary—Miss Grace Hood, Lewis Institute.

Upon motion of Miss Conley, the section voted to instruct the Secretary to cast the ballot for these persons as officers for 1916.

Report of the Committee on Nomenclature was then called for. The report by Miss Van Hosen, University of Chicago, Chairman, was read by Miss Firth of Davenport. It suggested the appointment of a home economics teacher to the N. E. A. Committee on Vocational Guidance, who are formulating definitions similar to those which this committee was called upon to make; and asked that this committee be continued for another year. Miss Marlatt then called attention to the fact that N. E. A. already has a committee of home economics teachers at work along this line. Upon motion of Miss Conley of Wisconsin, it was voted that the Committee on Nomenclature should be continued for another year.

Paper, "Dietetics and Dietaries in High School"—Edna White and Minna Denton, University of Ohio.

Paper, "Experimental Work in Textiles for the High School"—Beatrice Hunter, University High School, Chicago.

Brief discussion by Mrs. Charlotte Gibbs Baker, University of Illinois, who suggested that if possible pupils should examine textile fibers with microscope; and that the alkali test might be taken up, at least as demonstration work by the teacher.

Section then adjourned.

MINUTES OF THE MATHEMATICS SECTION, CENTRAL ASSOCIATION.

The meeting, Friday afternoon, was called to order by the Chairman, Miss Edith Long of Lincoln, Neb.

Miss Edna Allen of Cedar Falls, Iowa, presented the report of the Committee on the Correlation of Secondary Mathematics. The report dealt with the nature and purpose of unified mathematics, the ways, means and advantages of unifying mathematics and correlating it with the metrical sciences. Unified mathematics had its beginning in the demand for utility and is supported by history, psychology and successful experience. Replies to a questionnaire sent out last spring show that many schools correlate the various branches of mathematics that are not giving unified mathematics. Among the schools giving unified mathematics are the high school at Lincoln, Neb., and the University High School, Chicago, Ill.

Dr. G. W. Myers of the School of Education, University of Chicago, spoke on "Current Educational Movements and General Mathematics." Dr. Myers had no written paper. His general thesis was that unified mathematics is in accordance with the dominant educational tendencies of the times. He made the following points:

1. General mathematics eliminates the lack of contiguity in mathematics work in the high school.

2. The point of view of general mathematics is psychological.
3. General mathematics eliminates the "lock step" in class work.
4. General mathematics has high adaptability to individual needs.
5. General mathematics is practical in content and method.

The formal discussion was opened by Mr. H. E. Cobb of Lewis Institute, Chicago. Mr. Cobb said that the problem confronting us is to make mathematics as taught, efficient. We keep algebra and geometry apart largely because the ancient Greeks did. Praise is due to Miss Long for the work in Lincoln, Neb., and to the work of the University High School, Chicago, Ill.

The discussion was continued by Miss Ella Woodyard of Kansas City, Kan. Miss Woodyard said that it was the province of teachers in secondary schools to readjust subject matter to democratic civilization. The high school teacher is often dissatisfied with results and is alarmed by the fact that pupils who have passed the required examinations are often ignorant, inaccurate and illogical. Unified mathematics helps to solve these problems and may be especially useful in junior high school work. When so used it shortens the work and gains time.

The report of the Committee on Vocational Mathematics was presented by Mr. K. G. Smith of Ames, Iowa. The report treats in detail—(1) of the application of algebra to the problems of industry, especially along the lines of formulas, equations and graphs; (2) of the applications of geometry and trigonometry to the problems of industry; (3) of applications to problems of agriculture; (4) of applications to problems of domestic science.

The following points were brought out in the general discussion:

Miss E. C. Ackerman, Lockport, Ill.: Many really practical problems are too difficult for ordinary classroom work. For example: Divide a circular bin in the ratio of 2:1 by a vertical partition.

Miss E. Jaynes, Lane Technical High School, Chicago: The main problem in teaching vocational mathematics is to present the necessary mathematics topics in language that can be comprehended by tradesmen and apprentices, most of whom have left school at the seventh, eighth or ninth grade.

The meeting, Saturday morning, was opened by Dr. L. C. Karpinski of the University of Michigan, who spoke on the history of algebra. His talk was illustrated by lantern slides and included the following topics:

I. Graphic Solution of Quadratic Euations by Greeks and Arabs.
II. Egyptian Mathematics, Including the Solution of Equations and the Summation of Arithmetical and Geometrical Progressions.
III. Babylonian Mathematics, Including the Summation of Progressions and Tables of Squares and Cubes.
IV. The Work of Euclid.
V. The Work of Archimedes.
VI. The Work of the Arabs, Showing Photograph of Pages of Latin Translation of Arabic Manuscripts.
VII. Sample Pages from the Earliest Printed Books on Arithmetic and Algebra.

The formal discussion was opened by a paper prepared by Miss Christine Bednar of the Parker High School, Chicago, Ill. As Miss Bednar was unable to be present, her paper was read by Miss J. McDonald. Miss Bednar thought that the use of historical notes in high school mathematics classes should be incidental.

The following points were brought out in the general discussion that followed:

Miss Flagg, Chicago: The Open Court photographs of famous mathematicians add interest to mathematics work.

Miss Shoesmith, Chicago: The Hyde Park High School Mathematics Club has been interested in some topics in the history of mathematics.

Miss Mabel Sykes, Chicago: The Bowen High School Mathematics Club has been interested in the early forms of equations, the early use of the abacus in multiplying and dividing and in the history of the Arabic numerals.

Mr. W. E. Beck, Iowa City: *The Mathematics Teacher* of December, 1914, had an article on the methods of multiplication used by Russian peasants, that is of interest to mathematics clubs.

Mr. E. R. Breslich, Chicago, then presented the report of the Committee on Geometry. The report treats of:

I. The Textbook in Geometry—Its Uses and Purposes.
II. Principal Purposes in the Teaching of Geometry.
III. Propædeutic Geometry.
IV. Foundations of Geometry.
V. Method.
VI. Content.
VII. Applications.
VIII. The Function Idea.
IX. Correlation with Algebra.
X. Historical Notes.
XI. Limits and Incommensurables.
XII. Equipment.

The following business was transacted: The various committees appointed at the 1914 meetings were continued with power to enlarge. This includes the Committee on Correlation of Secondary Mathematics, on Vocational Mathematics, on Algebra, on Geometry and on Publicity. The Committee on Applied Problems, authorized but never appointed, is to be appointed by the incoming Chairman.

The following officers were elected:

Chairman—Dr. J. W. A. Young, Chicago.
Vice-Chairman—Mr. F. C. Touton, St. Joseph, Mo.
Secretary—Miss E. Marie Gugle, Columbus, Ohio.

MABEL SYKES,
Acting Secretary.

MINUTES OF THE PHYSICS SECTION.

Program.

Chairman—Theodore L. Harley, Hyde Park High School, Chicago.

Vice-Chairman—H. E. Hammond, Central High School, Kalamazoo, Mich.

Secretary—Earl R. Glenn, Carter H. Harrison Technical High School, Chicago.

Chairman Reception Committee—Willis E. Tower, Englewood High School, Chicago.

Friday, November 26, 1:30 p. m.

Appointment of committees.

"The Elimination of Waste in the Teaching of Secondary School

Science"—Robert A. Millikan, Professor of Physics, University of Chicago.

Discussion led by Charles H. Smith, Hyde Park High School, Chicago; Willis E. Tower, Englewood High School, Chicago.

News Items from the Apparatus Manufacturers—Central Scientific Company, Weston Electrical Instrument Company.

Saturday, November 27, 10 a. m.

Election of officers.

"Commercial Applications of the Laws of Physics"—Philip B. Woodworth, Lewis Institute, Chicago.

"Physics Teaching and the Community"—James E. Weyant, Shortridge High School, Indianapolis.

General Discussion.

The topic for this meeting was chosen with special reference to getting the general experience of our membership in adapting the subject to community interests.

Excursion—1:15 p. m.—The Great Lakes Naval Training Station. Includes the new high power radio station which is now in use in transcontinental service. Leader, E. E. Burns, Medill High School, Chicago.

Friday Afternoon Session.

The Chairman, Mr. Theodore L. Harley, called the section to order at 2:00 p. m., in the physics department of the Carter H. Harrison Technical High School. About ninety members were present during the afternoon. The Chairman then appointed as Nominating Committee Mr. Franklin T. Jones, University School, Cleveland, Ohio, Mr. W. H. Ahrens, Englewood High School, Chicago, and Mr. C. H. Smith, Hyde Park High School.

The first lecture of the afternoon, "The Elimination of Waste in the Teaching of High School Science," was given by Robert A. Millikan, Professor of Physics, University of Chicago. Next, "A Discussion of Dr. Robert A. Millikan's Paper on 'The Elimination of Waste in the Teaching of Secondary School Science,'" was given by Mr. Charles H. Smith, Hyde Park High School, Chicago.

The third paper was read by Mr. Willis E. Tower, Englewood High School, Chicago. The speaker enumerated sources of *waste* in teaching, not mentioned by the previous speakers and described a plan adopted by the "Engleboosters Association of Englewood High School," a student organization, to teach high school pupils *how to study*.

Before the general discussion of the above program, Mr. E. E. Burns, Medill High School, Chicago, described the proposed Saturday afternoon excursion of the Physics Section to the Great Lakes Naval Training Station. At this place a new high power radio station is in transcontinental service.

Discussion.

The following teachers spoke extemporaneously concerning the papers which were given during the afternoon:

Professor John C. Hessler, James Millikin University, Decatur, Ill.
Mr. F. T. Jones, University School, Cleveland, Ohio.
Mr. Fred R. Nichols, Crane Technical High School, Chicago.
Mr. Willis E. Tower, Englewood High School, Chicago.
Mr. Charles E. Linebarger, Lake View High School, Chicago.
Mr. Charles H. Smith, Hyde Park High School, Chicago.
Mr. W. C. Hawthorne, Crane Technical High School, Chicago.
Mr. N. H. Black, Roxbury Latin School, Boston, Mass.
Mr. T. L. Harley, Hyde Park High School, Chicago.

At the close of the meeting members of the section listened to representatives of:

(*a*) Central Scientific Company, Chicago, concerning:
1. A new type of electrometer.
2. New specific gravity apparatus.
3. Two types of universal shunts.
4. New line of tuning forks, made in U. S. A.
5. New line of variable rheostats.

(*b*) Weston Electrical Instrument Company, Newark, N. J., concerning:
1. Improved form of wattmeter for D. C. or A. C. power measurements.
2. New type of precision ammeter.
3. Model 155 ammeters and voltmeters for either A. C. or D. C. measurements.
4. A galvanometer with a scale set at 45 degrees from the base.

The section adjourned at about 4:30 p. m.

Saturday Morning Session.

The section was called to order at 10:30 a. m. by Mr. T. L. Harley. About thirty-five members were present. The Nominating Committee gave a report upon officers for 1916 as follows:

Chairman—Earl R. Glenn, Carter H. Harrison Technical High School, Chicago.

Vice-Chairman—Charles T. Prose, High School, Zanesville, Ohio.

Secretary—James E. Weyant, Shortridge High School, Indianapolis, Ind.

A motion was made, seconded and passed that the Secretary of the section be instructed to cast a ballot for the election of the new officers named by the Nominating Committee.

The section then enjoyed a most interesting lecture given by Dean P. B. Woodworth, Lewis Institute, Chicago, upon the "Commercial Applications of the Laws of Physics." The speaker showed the simplicity of certain methods for measuring the velocity of liquids and gases, and gave demonstrations with commercial apparatus, designed to measure the velocity of water in hydraulic systems.

The second paper on the program, "Physics Teaching and the Community," was given by Mr. James E. Weyant, Shortridge High School, Indianapolis, Ind. The members of the section discussed the course in *advanced electricity* described by Mr. Weyant, and made several suggestions concerning the advisability of devoting three semesters instead of two to the subject of physics.

The section adjourned at 12:30 p. m. to make a visit to the Great Lakes Naval Training Station.

EARL R. GLENN,
Secretary.

REPORT ON PLATINUM.

In the annual statement on the production of platinum and allied metals in 1914, now available for distribution by the United States Geological Survey, 570 ounces of crude sand, with a value of $18,240, is reported to have been produced. This expensive metal is not used so freely in the dental and electrical industries as formerly, being partly replaced by cheaper metals.

BUTTERMILK AND BACTERIA.

The popularity of buttermilk as a food and a beverage is attested by its widespread sale. Any drink which can succeed in invading the precincts of the saloon, and compete for sale, as buttermilk now does, side by side with alcoholic beverages, deserves attention. The plan of allowing milk to undergo fermentation of such a character that the products are not unpleasant or unwholesome for human consumption, yet serve as preservatives to prevent undesirable types of decomposition, is not new. The fermentation product chiefly depended on in such cases is lactic acid, although, in certain types, alcoholic fermentation may also be in evidence. Buttermilk belongs to the acid type; it usually contains from 0.6 to 0.9 per cent of acid. Strictly speaking, buttermilk is a by-product of butter-making; but with the development of the milk industries, the demand for buttermilk has frequently been met by fermenting the skim or separator milk which remains as a by-product of the cream trade. The fermented product is not literally buttermilk, but it may be indistinguishable from the latter in composition and properties. The use of these fermented milk products has been favored, not alone for their intrinsic food value, but also for accessory reasons. The specific fermentation products have been reputed to have a "tonic" action in the digestive tract. Special virtues have been attributed to the lactic acid bacteria, particularly in relation to putrefactive changes in the alimentary tract. Aside from any alleged therapeutic virtues, there can be no doubt of the nutrient value of the beverages. With the growing attention devoted to the bacteria which milk may harbor, and the recognition of the dangers which they may entail, it is not strange that buttermilk also should demand bacteriologic consideration. Heinemann, of the Department of Bacteriology and Hygiene at the University of Chicago, has demonstrated that the presence of lactic acid in milk will destroy the germs of dysentery, typhoid, diphtheria and cholera. The slower milk sours, the greater is the danger of disease germs surviving. Acids other than lactic acid are frequently present in buttermilk. This beverage, Heinemann reminds us, should therefore be looked on with suspicion, especially if heavily polluted, unless it has been prepared from pasteurized milk. There is, however, says *The Journal of the American Medical Association,* a remnant of satisfaction to all lovers of the fermented product to learn that the chances of buttermilk becoming a carrier of infection are small.

The annual statement of the Geological Survey on gold, silver, copper, lead and zinc in California and Oregon in 1914 is now available for distribution. During the year the 658 producing mines in California yielded a total production of these minerals valued at $25,710,645, and the production of 105 producing mines of Oregon reached a total value of $1,676,153.

ARTICLES IN CURRENT PERIODICALS.

American Journal of Botany for December; *Brooklyn Botanic Garden, Brooklyn, N. Y.; $4.00 per year,* 50 cents a copy: "A Brief Sketch of the Life and Work of Charles Edwin Bessey, Raymond J. Pool; "Heredity and Mutation as Cell Phenomena," *R. Ruggles Gates;* "The Relation Between Vegetative Vigor and Reproduction in Some Saprolegniaceae," Adrian J. Pieters.

American Mathematical Monthly for December; *5548 Kenwood Ave., Chicago, Ill.; $2.00 per year;* "An Experiment in Correlating Freshman Mathematics," *F. L. Griffin;* "Linkages," D. H. Leavens; "The Probable Rank in a Large Class of a Student of Given Rank in a Small Class," L. D. Ames.

Condor for November-December; *Los Angeles, California; $1.50 per year, 30 cents a copy:* "The Yellow-billed Loon: A Problem in Migration," Wells W. Cooke; "Notes on the Nesting of the White-tailed Ptarmigan in Colorado" (with five photos), W. C. Bradbury; "Characteristic Birds of the Dakota Prairies," II. "Along the Lake Borders," Florence Merriam Bailey; "Further Remarks upon the Kern Redwing," Joseph Mailliard; "Nesting of the White-tailed Kite at Sespe, Ventura County, California" (with two photos), Lawerence Peyton; "Additional Observations on the Birds of the Lower Colorado Valley in California," A. Brazier Howell and A. van Rossem.

Educational Administration and Supervision; Baltimore, Md.; $2.00 per year, 25 cents a copy: "Proposed Status Instruction of Science in the Junior-Senior High School Organization," John G. Coulter; "A Laboratory Exercise in School Administration," Carter Alexander; "Cheating in High School," Anna Eichhorn.

Journal of Educational Psychology, for November; *Baltimore, Md.; $2.50 per year, 30 cents a copy:* "A New Scale of Mental and Physical Measurements for Adolescents, and Some of its Uses," Helen Woolley; "The Stanford Revision of the Binet-Simon Scale, and Some Results from its Application to One Thousand Non-Selected Children," Lewis M. Terman, Grace Lyman, George Ordahl, Louise Ordahl, Neva Galbreath, and Wilford Talbert.

Journal of Geography for January; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "Supplying the World's Coffee," Chester L. Jones; "Supplementary Material for Teaching Geography in Elementary Schools," J. W. Hubbard; "Geography in Detroit Elementary Schools," Burton A. Barnes; "The Making of a Great Modern Harbor—Liverpool," K. W. Davidson.

L'Enseignement Mathématique for September-November; *G. E. Stechert & Co., 151 West 25th St., New York; 15 francs per year, 2 francs a copy:* "Propriétés involutives dualistiques des triangles," L. Crelier; "Remarques au sujet de la construction des centres de courbure des coniques," M. d'Ocagne; "Le probléme de Jean de Palerme et de Léonard de Pise," E. Turriére; "The Preparation of Mathematics Teachers in the United States of America," G. A. Miller.

Mathematical Gazette for October; *G. Bell & Sons, Portugal St., Kingsway, London; 6 nos. 9s. per year, 2s., 6d. a copy:* "A Study of the Life and Writings of Colin Maclaurin," C. Tweedie; "The Solution of Numerical Equations," E. H. Neville.

Nature-Study Review for December; *$1.00 per year, 15 cents a copy:* "Training Teacher to Teach Nature Study," Alice J. Patterson; "Training to Teach Nature-Study in Ontario," John Dearness; "Subject Matter versus Methods," Gilbert H. Trafton; "Human Interest and Nature Study," C. F. Hodge; "College Freshmen, an Index of Progress," Jas. G. Needham; "Some Fundamental Propositions," M. A. Bigelow; "The Course in Nature Study with Prospective Teachers," Fred T. Ullrich; "Nature Study in the Geneseo Schools," Josephine Bailey; "The Tussock Moth," Mary L. Dougherty; "Intensive Gardening," Elizabeth Sheppard.

Photo-Era for January; *Boston, Mass.; $1.50 per year, 15 cents a copy:* "Portrait-Lighting with Mercury-Vapor Lamps," Gerhard Sisters; "The Eyes in Portraiture," W. Howard Valentine; "Modifying Negatives for Enlargement," Phil M. Riley; "More About Pyro-Acetone," William H. Zerbe; "A System of Finding Exposures in Bromide Enlarging," Anketell Henderson; "An Improved Automatic Plate-Washer," F. S. Dellenbaugh, Jr.; "Depth of Focus," Philip Conklin.

Physical Review for December; *Ithaca, N. Y.; $6.00 per year, 60 cents a copy:* "The Structure of γ Rays on the Basis of the Electro-Magnetic Theory of Light, Jakob Kunz; "Absorption of the β-Particles from some

of the Radioactive Substances by Air and Carbon Dioxide," Alois F. Kovarik; "Distribution of Transmitted and Reflected β-Particles Determined by the Statistical Method," Alois E. Kovarik and L. W. McKeehan; "A Method of Measuring Heat Conductivities," R. W. King; "On the Correct Formula for the Damping Factor in Highly Damped Periodic Motion of the Coil of the D'Arsonval Galvanometer," Lindley Pyle; "Electrical Oscillations from Mercury Vapor Tubes," Benjamin Liebowitz; "The Effect of Temperature on the Absorbed Charge and on the Capacity of Some Electric Condensers," Anthony Zeleny.

Popular Astronomy for January, *Northfield, Minn.; $3.50 per year, 35 cents a copy:* "The Eclipses of 1916," William F. Rigge; "The Giant Sun Canopus," (Translation), Charles Nevers Holmes; "The Graphical Computation of Transit Factors, Thornton C. Fry; "The History of the Discovery of Solar Spots," Walter M. Mitchell; "Gegenschein Configurations, W. E. Glanville; "Report on Mars, No. 13," William H. Pickering; "Astronomical Phenomena in 1916."

Psychological Clinic for December;*Philadelphia, Penn.; $1.50 per year, 20 cents a copy:* "Reproduction of Short Prose Passages: A Study of two Binet Tests," A. Travis; "The Social Treatment of Unmarried Mothers," Francis N. Maxfield, Ph.D.

School Review for December; *Chicago, Ill.; $1.50 per year, 20 cents a copy:* "The Problem of Individual Differences in the Teaching of Secondary-School Mathematics," Raleigh Schorling; "Training City Boys for Country Life," Robert J. Teall; "The School Phases of Vocational Guidance; Frank M. Leavitt.

School World for December; *London, England; 7s. 6d. per year:* "The War and the Teaching of Science," C. W. P. Rogers; "Rural Secondary Schools and Their Difficulties," William Aldridge; "Atlas, Textual and Wall Maps for School and University Use," (With Diagrams); "The School Medical Service."

Scientific Monthly for January; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "The Men of the Mid-Pacific," Dr. Alfred G. Mayer; "Governmental Obstacles to Insurance," Chancellor David S. Jordan; "Defending America," Wm. J. Roe; "The Younger Generation of American Genius," Scott Nearing; "Museum Fatigue," Benjamin Ives Gilman; "The Function of Milk in the Scheme of Evolution," Dr. Henry D. Chapin; "Professional Contributions to Invalidism," Dr. Robert S. Carroll; "Is Selection or Mutation the More Important Agency in Evolution?" William E. Castle.

Unterrichtsblätter für Mathematik und Naturwissenschaft, No. 7; *Otto Salle, Elssholzerster. 15, Berlin W. 57, Germany; M. 4 per year, 60 Pf. a copy:* "Biologie und Volkswirtschaft," Prof. Dr. R. v. Hanstein; "Neue Kegelschnitteigenschaften," Dr. E. Magin; "Interessante Eigenschaften der quadratischen und Kubischen Gleichungen," Prof. P. Kiesling; "Zum Kreise des Apollonius," Oberlehrer Willy Weber; "Ueber das Maginsche Parallelogrammbüschel," Prof. Joh. Kleiber.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht Aller Schulgattungen for November; *B. G. Teubner, Leipsic, Germany; 12 nos. M. 12 per year:* "Flüssige Luft beim Unterricht," Prof. H. Rebenstorff; "Zur historischen Durchdringung des mathematischen Unterrichts," Oberlehrer Dr. J. Quandt; "Archimedische Methode oder Trapezverfahren?" H. Deutsch; "Erwiderung," A. Flechsenhaar.

BOOKS RECEIVED.

A Brief Course in Algebra, by Raymond E. Manchester, State Normal School, Oshkosh, Wis. 198 pages. 13x18.5 cm. Cloth. 1915. C. W. Bardeen, Syracuse, N. Y.

The Fourth-Dimensional Reaches of the Exposition, by Cora L. Williams. Pages 19. 12.5x20.5 cm. Paper. 1915. Paul Elder & Co., San Francisco, Cal.

The Adolescent Period, by Louis Starr, College of Physicians, Philadelphia. Pages vii+211. 13x19 cm. Cloth. 1915. P. Blakiston's Son & Co., Philadelphia.

First Aid in the Laboratory and Workshop by Arthur A. Eldridge and H. V. A. Briscal, England. Pages V+32. 12x18.5 cm. Cloth. 1915. 35 cents net. Longmans, Green & Co., New York.

The Development of the Human Body, by J. Playfair McMunich. University of Michigan. Pages X+493. 14x20 cm. Cloth. 1915. $2.50. P. Blakiston's, Son and Co., Philadelphia.

A Handbook of Colloid-Chemistry, by Wolfgang Oslwald, Leipzig, and Martin H. Ficher, University of Cincinnati. Pages xii+278. 16x24 cm. Cloth. 1915. $3.00 net. P. Blakiston's, Son and Co., Philadelphia.

BOOK REVIEWS.

High School and Class Management, by Horace A. Hollister, University of of Illinois. Pages xvii+314. 13.5x19.5 cm. Cloth. 1915. $1.25. D. C. Heath & Co., Boston.

If all teachers were as willing to help themselves as progressive textbook writers are to help them, there would be such a remarkable increase in the efficiency of secondary school teaching that even the instructors themselves would be amazed. The growth of the secondary school problem from all points of view has been so tremendously rapid during the last two decades that the management of the classroom as well as of the school itself has become almost a distinct science. There is no single person in all the world more competent to write on this subject than the author of this splendid volume. He has had great experience, and has visited hundreds of schools and thousands of classrooms, and has brought together a mass of information covering all phases of this most interesting problem. He has presented the matter in this book in such a form as to compel all secondary school-teachers to stop and become familiar with the lessons which he gives to them. He differentiates clearly between class management and the technique of teaching. The book should be studied by all people who intend to make of themselves successful teachers. C. H. S.

Plane Trigonometry, by A. M. Harding, Associate Professor of Mathematics, and J. S. Turner, Instructor in Mathematics, University of Arkansas. Pages xiii+158+51. 13x19 cm. $1.10 with tables. 1915. G. P. Putnam's Sons, New York.

Among the special features of this book mentioned by the authors are: An introductory chapter on geometry; the introduction of the trigonometric functions, two at a time; the practical side emphasized at the outset; very complete treatment of logarithms included in the text; an illustrative example for every process; and a chapter on the applications to geometry.

While this text meets the requirements of first-year college students, it is well adapted for use in high schools. The illustrative examples are worked out in good form, and all the work is arranged in an orderly fashion. This is a great aid to the student in memorizing results, and learning methods of procedure. The large number of exercises, about 600, gives the teacher considerable opportunity for selection. H. E. C.

Magnetism and Electricity, by E. W. E. Kempson, Rugby School. Pages viii+240. 13x19 cm. Cloth. 1915. 90 cents net. Longmans, Green & Co., New York City.

The days of good bookmaking have not yet passed. When one reads the pages of this volume, this fact is brought strongly home to him. The

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book is made up very largely from lecture notes covering a year's work on electricity and magnetism as given to the science forms in the upper school at Rugby. The author attempts to correlate and show the intimate relation existing between the static phenomena of electricity and that of current electricity. The book presupposes that the student should have at least two hours of practical work in the laboratory. The experiments are comparatively simple, and are such as might be given in the physics department of a modern, well-equipped high school. The volume is well worth a place in the library of every physics teacher. C. H. S.

Introduction to Science, by Bertha M. Clark, Wm. Penn High School for Girls, Philadelphia. 494 pages. 13x19 cm. Cloth. 1915. American Book Co., Chicago.

This is a book which has been written by a person who has devoted many years to the study of science, especially among the eighth and ninth grades. She has produced a book which stands at the very topmost round of the ladder in this phase of science teaching. The writer of this review has no words of adverse criticism to offer, but on the contrary has nothing but commendation and praise for the nature and character of the book. The illustrations, of which there are 346, have been selected with care, and they tell the story that they are intended to teach, in a graphic way. The volume makes interesting reading for the ordinary layman, and will even interest the person who considers himself above dabbling in the science of the eighth and ninth grades. The diction is splendid. The mechanical work is of the highest type of bookmaking. The major paragraphs all begin with bold-faced type. The volume deserves a wide circulation. C. H. S.

A Budget of Paradoxes, by Augustus De Morgan, Second Edition, edited by David Eugene Smith. Vol I, 402 pages. Vol. II, 387 pages. 16x23 cm. $7.00. 1915. The Open Court Publishing Company, Chicago.

Augustus De Morgan (1800-1871) was one of the most eminent mathematicians and logicians of his time. As a teacher he was unrivaled and as an author his work contributed powerfully towards the progress of mathematics. He was a true lover of books and gathered into his library many curious and rare books. This budget comprises the articles originally published in the *Athenæum* with similar articles which were added in the first edition. They describe various attempts that have been made to invent a perpetual motion, to square the circle, to trisect an angle, and so on, and also include many curious bits gathered from the large number of books in his library and from correspondence and interviews with *discoverers*.

The word paradox is used in the old sense—a paradox is something which is apart from general opinion, either in subject-matter, method, or conclusion. "The manner," he says, "in which a paradoxer will show himself, as to sense or nonsense, will not depend upon what he maintains, but upon whether he has or has not made a sufficient knowledge of what has been done by others, *especially as to the mode of doing it*, a preliminary to inventing knowledge for himself."

It is not possible to give an adequate enumeration of the large number of topics which are treated in a most interesting fashion. A few topics taken at random will indicate something of the range: Bacon's Novum Organum; inhabitable planets; astrology; lunar motions; zetetic astronomy; aviation; alchemy; the steamship suggested; a forerunner of the metric system; a new era in fiction; on youthful prodigies; a discourse on probability; logic has no paradoxes; decimal coinage; π, thirty references; squaring the circle, thirty-three references; and the trisection problem, five references. The index contains about 1,200 names.

In issuing these volumes The Open Court Publishing Company places under renewed obligations all who are interested in science and mathematics. The selection of Dr. Smith for the labor of editing the Paradoxes was most opportune; no other person in this country is so well qualified to undertake this work. The footnotes he has supplied furnish the reader with the information necessary to a satisfactory understanding of the text.

H. E. C.

Teaching, Its Aims and Methods, by Levi Seeley, New Jersey State Normal School. Pages xi+320. 13x19 cm. Cloth. 1915. $1.25. Hinds, Noble & Eldredge, New York City.

There are many teachers in secondary schools who seem to be under the impression that when they have finished their college course they are abundantly qualified and equipped with all of the necessary working tools, methods, etc., to instruct the average high school pupil in their particular subjects. What a false notion this is! This book has been written by a past master on the subject, and contains information with which every practical high school teacher should be familiar. Those who have not been able to avail themselves of the privilege of a course in a professional school, but who are obliged to prepare themselves independently, will find in this treatise information which will be of the greatest help. The volume is written in a style which is simple, free from technical terms, and clear. The thought is concisely given and conclusive, and the reader will be at once interested in what the author has to say. All secondary school-teachers of whatever subject should secure this book and make a study of it.

C. H. S.

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Iceland; Horse Back Tours in Saga Land, illustrated from photographs by the author, by W. S. C. Russell, 314 pages. 14x20 cm. Cloth. 1914. $2.00. Cambridge Botanical Supply Co., Waverley, Mass.

The author is one of the most widely known science teachers in New England. For the past eleven years he has been Director of Science in the Central High School, Springfield, Mass. "Iceland" embodies the results of four summers of extensive travels in Iceland, in 1909, 1910, 1911 and 1913. In 1911 the author was the geologist of the Matador party of scientists to Jan Mayen. In 1913 Mr. Russell led an expedition to the summit of Mt. Askja, the largest volcano in Iceland, then crossed north of Hoffs Jökull, where man had never been, and reached the south coast, going down between the glaciers.

An exhuastive study of the country and its people, their customs and traditions, as well as their rich literature, is here recorded. The author has lived with the people under all conditions, enjoyed their remarkable hospitality and tells the reader all about their morality, freedom from crime and their high attainments in educational matters. The book is an appreciative narrative of four years of unaccustomed travel, coupled with delightful descriptions of the country in word-pictures that are realistic and force the reader to long for a visit to this same Arctic land.

Vivid word-pictures bring the beauty and magnificence of Iceland to the reader. With the author you will cross smoking mountains, ascend living volcanoes, ford glacial torrents, descend into the bowels of the lava fields, thread the wind-swept, dreary, lifeless and rock-strewn desert, and pass your evenings in the homes of the kindly farmers whose customs are those of a thousand years ago.

"Iceland" is one of the most interesting books of travel the writer has ever read. It is also a mine of information about the history, literature, climate and geology of this most interesting and wonderful island.

C. M. T.

How to Study and What to Study, by Richard L. Sandwick, Deerfield Shields High School, Highland Park, Ill. Pages v+170. 12x17 cm. Cloth. 1915. 60 cents. D. C. Heath & Co., Boston.

A book which will fill a niche which has long been vacant in the list of books for high school pupils' use. It is a sad commentary on secondary school education in America that the pupils are not taught to any great extent how to best use their time and how to study when they first enter high school. This book should be placed where every high school pupil can have access to it. It presents in clear and usable form the most successful methods by which class assignments can be learned. It is perfectly possible to use the volume in connection with first year English courses. It will be invaluable to those teachers who wish to advocate the best kind of supervised study. Its scholarly qualities are beyond question, and it is a book which every secondary school-teacher should possess and study.

C. H. S.

The Trees and the Shrubs of Northeastern America, by Charles S. Newhall. 250+240 pages. 14.5x21 cm. $2.00. Putnam's.

The present volume represents a new impression of the author's tree book and shrub book, formerly bound separately but now issued in one volume. The reviewer has used both of these books for a good many years and has found them practically very satisfactory. The fact that they were originally published about twenty-five years ago may justify the feeling that the publishers would have done well to take the present opportunity to revise them.

W. L. E.

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21 East End Street **Cambridge, Ohio, U. S. A.**

Plane Analytic Geometry, by Maxine Bocher, Professor of Mathematics in Harvard University. Pages xiii+235. 13x19 cm. 1915. Henry Holt & Company, New York.

It is the author's contention that analytic geometry if properly taught is a difficult subject. He has followed the Harvard tradition, that the one aim should be to furnish the student with an instrument which he can himself use in proving new geometrical theorems or solving problems. The important principles are emphasized while the less essential are omitted, or put in smaller type, or put in late chapters. The last two chapters give the elements of the differential calculus with some applications to curves. The author chooses to give this work as a new subject, rather than to make the natural connection with analytic geometry in the problem of finding tangents to curves.

A good deal of ground is covered because of the concise and straightforward way of putting things. If the book is followed closely, students will, no doubt, get a grasp of the analytic method of dealing with curves and a method of attacking new geometrical problems, which will be of great use in the further study of pure mathematics. H. E. C.

Elementary and Applied Chemistry, by Frederick C. Irwin, Head of the Department of Chemistry, Central High School, Detroit, Mich., Byron J. Rivett, Instructor in Chemistry, Northwestern High School, Detroit, Mich., and Orrett Tatlock, Instructor in Chemistry, Central High School, Detroit, Mich. Pages xv+495. 14x19x3 cm. Illustrated. Cloth. 1915. $———. Row, Peterson & Co.

The avowed purpose of the authors of this new chemistry for high schools is to try to "respond to the demand for making the teaching of chemistry more practical." While teachers of chemistry all over the country seem to be undergoing a revulsion of feeling in regard to this popular demand, it may be well, in the language of "The Mikado," to "let them dance a little or they'll want to dance a lot." Therefore, this new book with its applied bent may fill a place that will probably soon be vacated by the ultrautilitarian texts that have preceded it. The authors do not forget that principles are fundamental and the earlier part of the book is devoted to teaching the necessary foundation work in order that there may be something to "apply." This method necessitates a very early use of symbols and formulas. On pp. 11, 12 and 13 chemical calculations are begun. The pupils will of course be in the same fix as those teachers who were unable to state whether H_2O meant ice, water or steam, having no idea how such hieroglyphics are manufactured. The use of formulas so early in the course is probably designed to permit the more rapid imparting of chemical information.

The order of treatment of topics is in some respects novel and such changes from the old systematic order as the teaching of the chemistry of hydrogen chloride before that of chlorine are probably desirable. In fact, more of the same sort of thing might well have been done. For example, in the earlier chapters we have oxygen, hydrogen, water, where if the method of the authors in regard to HCl and Cl had been followed, we would probably have had air, oxgen, water, hydrogen. The college text still dominates the high-school text to too great a degree. The departures made in this new high-school text are a favorable omen.

The illustrations, while not especially numerous, are generally good. Some of the representations of minerals are especially good. The cut of a rotary kiln for making cement needs some object of known size within the picture for the sake of comparison as it gives the impression that it is of about the size of a magic lantern, whereas it is really over one hundred feet long.

JUST PUBLISHT

Smith's Commerce and Industry

By J. RUSSELL SMITH, *Professor of Industry in the Wharton School of Finance and Commerce of the University of Pennsylvania. 554 pp. 12 mo. $1.40*

The material of this commercial geography text-book is arranged by countries, but the subordinate arrangement under the United States is by industries. In discussing the industries of the United States the author followed them into other countries, thus giving an idea of their world-wide relations. In general, he has followed the plan of making comparisons between countries instead of confining the discussion to one locality at a time.

The usual plan of treating the physical geography of a country in a separate, formal statement, preliminary to the discussion of its industries is not followed in this book. On the contrary, the physical features are treated directly in connection with the industries themselves, thus bringing out the relations between them.

Half of the book is devoted to the United States. Of foreign countries, Latin American and the Orient receive unusual attention because of our future trade expansion with those countries.

World trade routes and certain generalizations, such as the laws of trade, are reserved for the last section because an understanding of them depends on a knowledge of the facts in the preceding sections. In this section, also, are certain interesting predictions in regard to the future development of industry. Among these are the utilization of the rocky hills of New England and the arid plains of the West by means of tree crops; the diversification of farming in the South by supply crops; the greater utilization, as coal and oil fail, of other sources of power, such as wind, water, tide, and even the sun; and the extraction of nitrogen from the air and phosphorus from the sea.

Many passages relating to the history of industry are interspersed in the text. A statistical appendix of twenty-four pages will be especially valuable to schools with limited reference libraries.

HENRY HOLT & CO.

34 West 33rd Street NEW YORK | **6 Park Street BOSTON** | **623 S. Wabash Ave. CHICAGO**

A laboratory manual is bound into the volume. It gives seventy-nine experiments, many of which are intended to convey information of applied chemistry. There are, for example, tests for cotton, silk and wool in fabrics; also tests of the per cent of water in potato, apple, meat, bread and milk; tests of the action of soap on hard and on soft water, etc. Many of the experiments, however, suggest to the reviewer that the authors really teach more of the fundamental principles of chemistry than their book would suggest on casual inspection and that the so-called practical applications are used by them more as interesting concrete examples than as a valuable basal material in the course, and this is as it should be.

F. B. W.

A First-Year Course in General Science, by Clara A. Pease, of the High School, Hartford, Conn. Pages 315+laboratory manual of 47 pages. Size 13.5x19x2 cm. Illustrated. Cloth. 1915. &———. Chas. E. Merrill Co.

One of the chief merits of this text in general science is that it attempts rather less than some of its competitors although the reviewer suspects that much pruning will be needed to reduce the field still further if any permanent educational advancement is to be expected in those who use the book.

The plan of attack is somewhat different from that in some other texts, astronomy furnishing the first two chapters. "Matter and Its Properties" comes next and this chapter deals with simple chemistry, physics and biology. The next four chapters are physical, dealing with force and motion, heat, liquids and gases. Meteorology next comes in for a chapter dealing with weather and climate. A return to physics gives us chapters on light, electricity and magnetism. Chemistry now receives more formal attention in the next four chapters. Seven chapters of a physiographic nature follow and the last five chapters are biological.

Thirty-one exercises for laboratory work follow and these furnish examples of the principal topics of the preceding chapters.

The text is written in an interesting style and furnishes a large amount of information that every child should become possessed of during his formal education. The illustrations are well chosen and well executed and will add to the interest of the book.

F. B. W.

Handbook of Mathematics for Engineers, by L. A. Waterbury, Professor of Civil Engineering, University of Arizona. Pages 213. 7.5x14 cm. Morocco. $1.50. 1915. John Wiley & Sons, Inc., New York.

This vest pocket reference book contains the important formulas of algebra, trigonometry, analytic geometry, calculus, theoretical mechanics, dynamics, mechanics of materials, and hydraulics used by the students of engineering. In addition there are tables of logarithms of numbers and trigonometric functions, natural functions, and conversion factors. This is a well-made and very convenient reference book.

H. E. C.

BOOKS ON CHEMISTRY

by Wilhelm Segerblom, A. B., Instructor in Chemistry at The Phillips Exeter Academy, Exeter, N. H.

TABLES OF PROPERTIES of over fifteen hundred common inorganic substances. An indispensable reference book for chemists, manufacturers, and science teachers. Gives common names, chemical and physical properties, and solubilities of common chemicals. 8vo, x + 144 pages. Cloth. $3.00 (prepaid).

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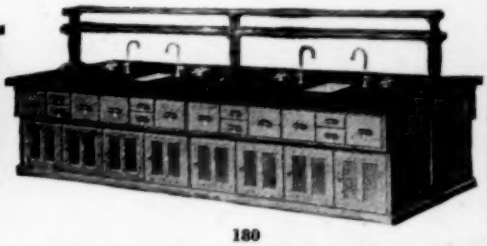

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Farm-Business Arithmetic, by Curtis J. Lewis. Pages xiii+199. 13x19 cm. 1915. D. C. Heath & Company, New York.

"Make the work of the school the talk of the home." "The live farmer does not have to hunt up paper and pencil every time he needs to do a little calculating or figuring." "A good seller is usually a successful farmer." "Soil efficiency+cow efficiency=farm prosperity." These maxims taken at random from those used by the author to open chapters of problems betoken a live and efficient farm-business arithmetic. Both good arithmetic and good farming can be learned from this book. Most of the problems have been taken from actual conditions within the range of everyday farm experience, and give the necessary drill in fractions, percentage, and so on. They include such topics as: "Farm Accounting," "Farm Business Forms," "The Harvesting Season," "Farm Feeding," "The Poultry Season," "Farm Occupations," and "Farm Management." That a large number of rural schools will use this book to the great advantage of the pupils is a safe prophecy. H. E. C.

School Arithmetic, Grammar School Book, by Florian Cajori. Pages ix+437. 14x19 cm. 1915. The Macmillan Company, New York.

This text for grammar schools has several noticeable features. There is a wide range of problems drawn from life on the farm, in the home, in the carpenter's shop, in the factory, and in the clerk's office. These vocational problems ought to be of value to the pupil after he leaves school. The work in graphical representation of empirical data, such as changes in temperature, prices of various commodities, and of agricultural and scientific data, is unusually well planned and can be comprehended and used by cildren. In the solution of many problems, letters are used to represent numbers, and simple equations are solved. Because of the simplification in technique and language of arithmetic, the well-ordered advance, and the wise choice of problem material, this series of arithmetics merits the consideration of teachers.

Second Course in Algebra, by William J. Milne, Late President of the New York State College for Teachers, Albany, N. Y. Pages 288. 12x18 cm. 1915. American Book Company, New York.

The methods and ideals of Dr. Milne which have been embodied in his numerous mathematical texts to the mutual advantage of teachers and pupils are evident in this book. The plan and scope have been determined by the recommendations of leading mathematical associations throughout the country, and by a study of courses of study in many states and cities. There are sufficient problems and exercises for a year's work. Equations and problems are emphasized. The formulas and applied problems are not outside the experience of pupils. The glossary and complete index will prove of great service. H. E. C.

School Algebra, Second Course, by H. L. Rietz and A. R. Crathorne, University of Illinois, and E. H. Taylor, Eastern Illinois State Normal School. Pages x+235. 13x19 cm. 1915. Henry Holt & Company, New York.

While this book contains material for thorough preparation for college, the authors have kept in mind the needs of the great body of pupils who do not enter college. A special effort has been made to obtain interesting problems which have real value, apart from the algebraic principles involved in their solution. Some of the problems have a physical setting which assumes no more technical knowledge than is possessed by the average high-school pupil. Complicated forms have been omitted in the exercises. Some typical college entrance examination questions are included in the numerous review exercises and problems. H. E. C.